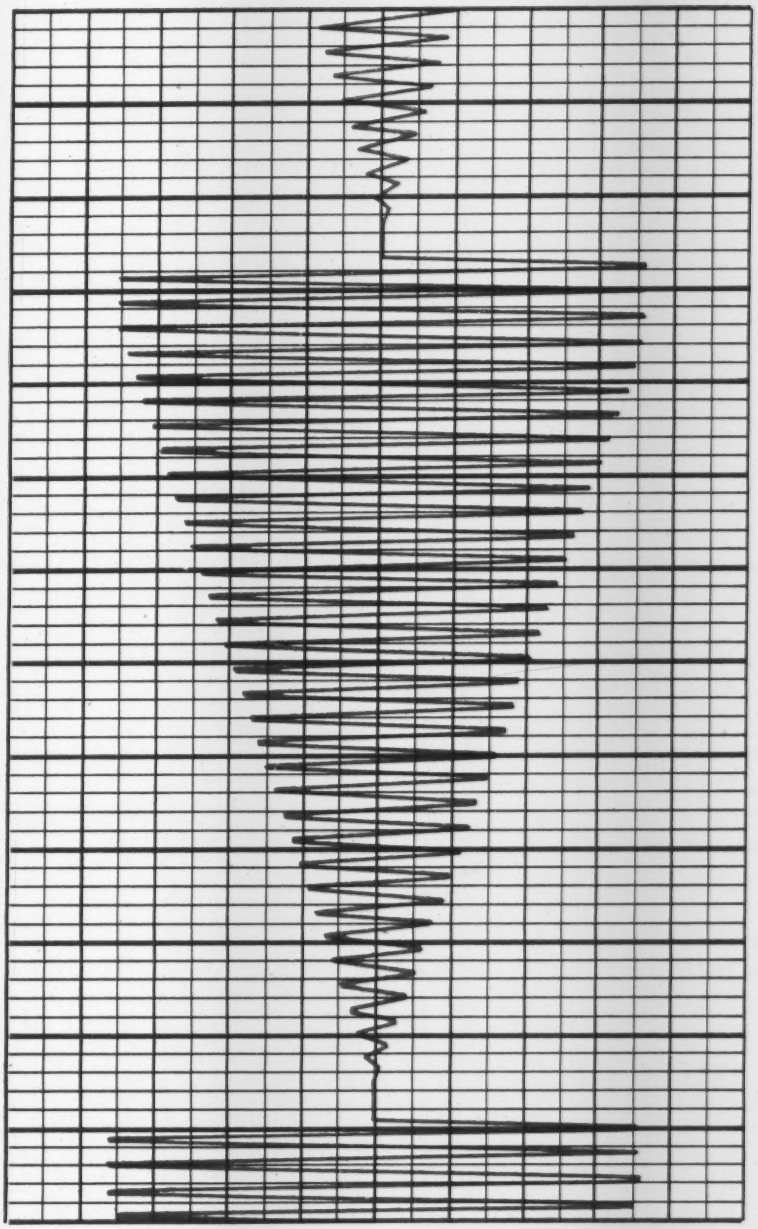
INSTRUMENTS AND CONTROL SYSTEMS

INCLUDING: JOURNAL OF THE SCMA • PRECISION MEASUREMENTS ASSOCIATION • SIMULATION COUNCIL NEWSLETTER

JULY 1961



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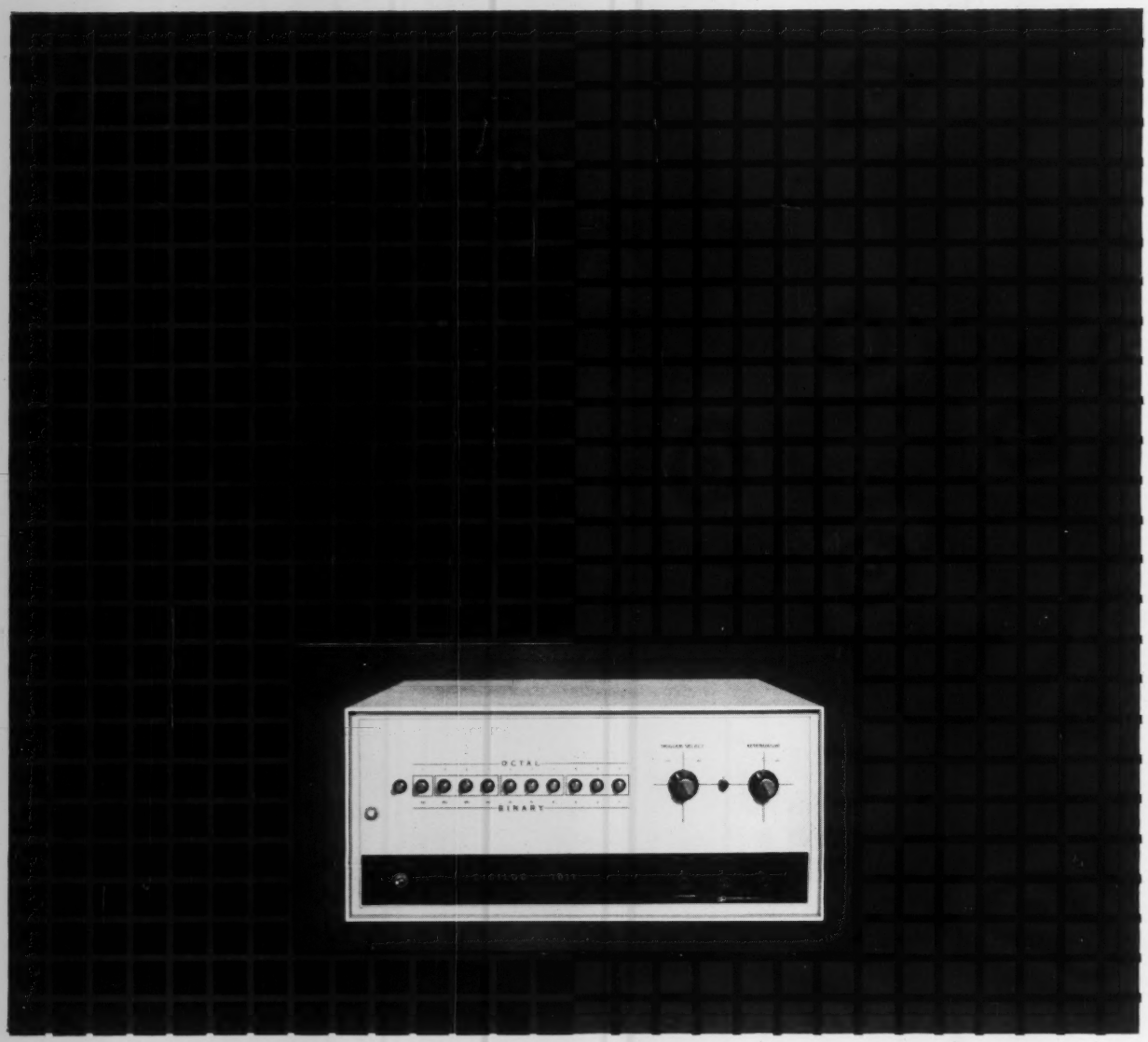
Trends in Photoprocessing 1235
Rapid-Access Oscillograph Recording 1236
Recording Terminology 1239
Recording Welding Variables 1241
Twistor Memories 1242
Magic Core Logic 1246



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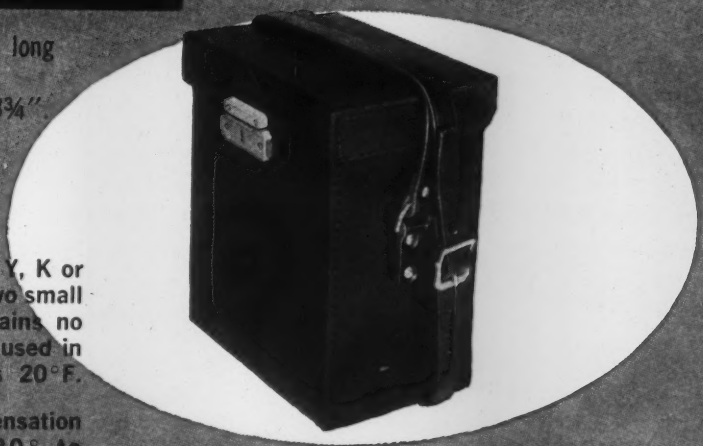

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CIRCLE 3 ON READER-SERVICE CARD

INSTRUMENTS AND CONTROL SYSTEMS

FEATURE ARTICLES

Trends in Photoprocessing 1235

GEORGE T. EATON—Immediate access to the image is often more important than a permanent record.

Rapid-Access Oscillograph Recording 1236

J. H. JACOBS—The two basic techniques use develop-out paper with rapid chemical processing, and print-out paper with rapid latensification.

Nomenclature for Direct-Writing Recorders 1239

FRED C. ZUSI—Terms that require careful definition include sensitivity, resolution, definition, maximum resolving power.

Recording Welding Variables 1241

L. S. WILKINS—A record of weld current, platen travel, upset force and forge force increases joint quality.

Twistor Memories 1242

PHILIP N. McCABE—No. 7 in memory series covers the twistor, a wrapping of magnetic material on a conductor.

Magnetic Core Logic 1246

ROBERT KODIS—All basic logic functions can be performed with this core-transistor element.

Filled-System Thermometers 1250

A staff survey of the instruments which perform the bulk of industrial temperature measurements.

Temperature Control by Stepped Resistance 1259

HAROLD ESKIN—This pivoted actuator opens or closes a series of contacts sequentially.

Pneumatic Digital Computer 1260

HUGH E. RIORDAN—Pneumatic digital devices can be packaged at 3000/cubic inch, and have 10-usec switching time.

Linear Dead-weight Accelerometer Calibrator 1262

HERMAN PINSKY—A simple technique for calibrating accelerators using only known weights.

VOLUME 34, NUMBER 7, JULY 1961

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INSTRUMENTS AND CONTROL SYSTEMS

VOL. 34 NO. 7
JULY 1961

Strain-Gage Temperature Compensation **1268**

LEON J. WEYMOUTH—An adjustable resistor in series with a platinum temperature-sensing element can minimize effect of temperature on a strain gage.

Journal of the Precision Measurements Association **1265**

SELF-QUALIFICATION OF LABORATORIES by A. T. McPHERSON—Laboratory management needs some means of evaluating laboratory performance.

Journal of the Southern California Meter Association **1266**

FRESH WATER FROM THE SEA by C. R. TOWNSEND—The economics of several techniques for saline water conversion.

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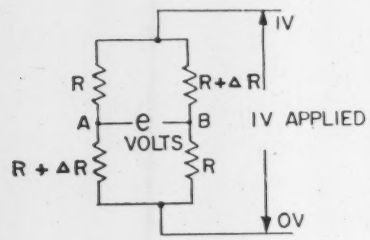
I&CS LETTERS TO THE EDITOR

Editor, I&CS:

I enjoy reading your publication *Instruments and Control Systems* each month since your articles are both informative and varied in subject matter.

The article "Strain-Gage Bridge Output" by W. E. Bostwick and H. C. McDonald in the May issue needs an addition to clarify their derivation. The derivation given is for a strain-gage bridge with only *one active arm*, and three fixed or inactive arms. Using the same notation as Messrs. Bostwick and McDonald, $(R + \Delta R)$ is the resistance of the active arm of the bridge, and this would have to be the lower left resistor in the illustration and proof used by the authors.

As a matter of interest to your readers, the proofs for two-active-arm and four-active-arm bridges are given in the following derivations, again using $(R + \Delta R)$ as the resistance of the active arms. For two



active arms, let the active arms be the lower-left and upper-right bridge arms. Then the voltage at points A and B are:

$$V_A = \frac{R + \Delta R}{R + (R + \Delta R)} \times 1$$

$$V_B = \frac{R}{(R + \Delta R) + R} \times 1$$

$$e = V_A - V_B$$

$$= \Delta R/(2R + \Delta R)$$

As ΔR is insignificant compared to $2R$:

$$e = \Delta R/2R$$

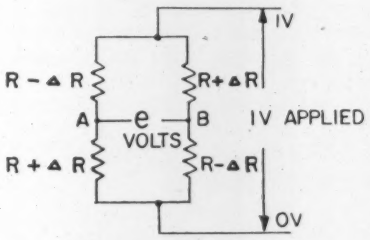
The Gage Factor, by definition, is:

$$GF = \frac{\Delta R/R}{\Delta L/L} = \frac{2e}{\Delta L/L}$$

Therefore,

$$e = \left(\frac{GF}{2}\right)\left(\frac{\Delta L}{L}\right)$$

For the four-arm bridge:



$$V_A = \frac{R + \Delta R}{(R - \Delta R) + (R + \Delta R)} = \frac{R + \Delta R}{2R}$$

$$V_B = \frac{R - \Delta R}{(R + \Delta R) + (R - \Delta R)} = \frac{R - \Delta R}{2R}$$

$$e = V_A - V_B = \Delta R/R$$

$$GF = \frac{\Delta R/R}{\Delta L/L} = \frac{e}{\Delta L/L}$$

$$e = GF\ (\Delta L/L)$$

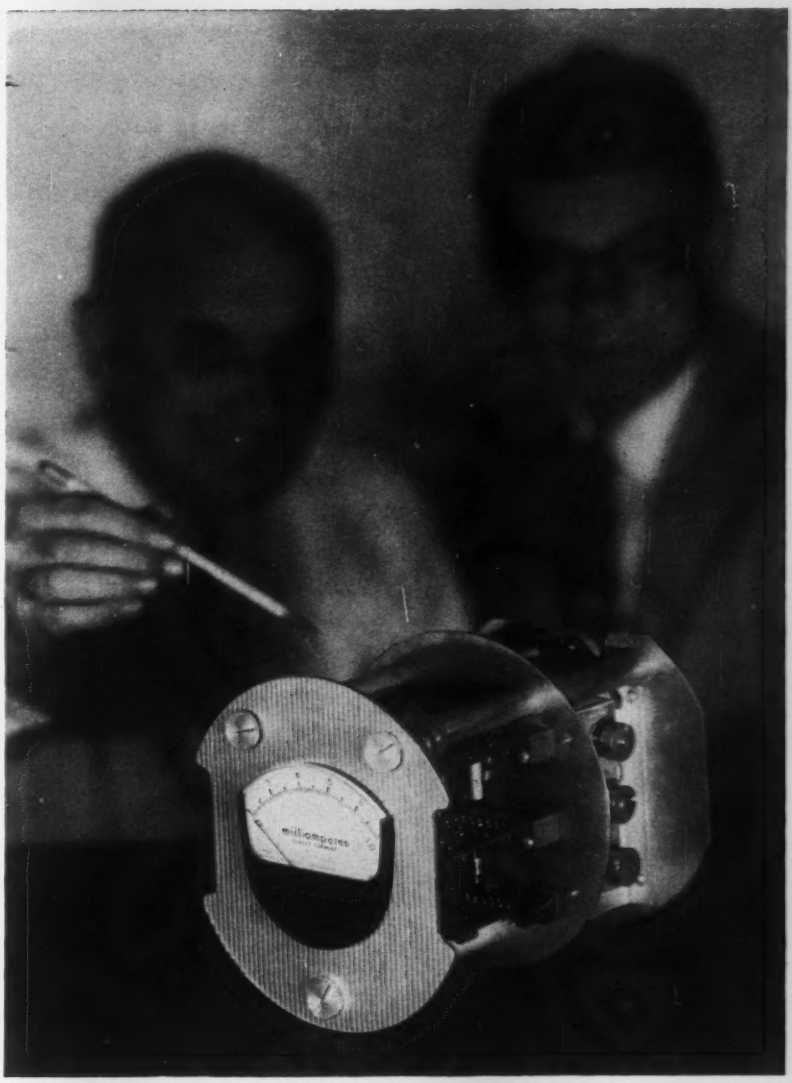
The bridge output voltage e is proportional to the number of active arms. With four active arms, e = GF volts per unit strain per volt applied, or *four times the output of the single-active-arm bridge.* Of course with the four active arm bridge, the strain-gages must be arranged so that two are in tension and two are in compression. The two-active-arm bridge is employed when the strain-gages can be used only in tension or compression.

Arno M. Meyer, Chief Engineer
Polyphase Instrument Company
Bridgeport, Montgomery Co., Pa.

Editor, I&CS:

In Mr. Scadrons' article, (New Techniques in Ceramic-Insulated Thermocouples, May, *I&CS*) he mentions that ±1 deg. F. accuracy is readily obtained, yet in his Table IIIB he indicated that ±200 microvolts is an expensive extra tolerance. At 1,800 deg. F. the ISA "K" tables show ±200 microvolts to be an error of ±9 deg. F.! One major user's specs call for ±100 mv., and SPS (single pass swaged) material normally runs ±60 mv. (at no extra charge).

There are excellent technical reasons for the higher calibration deviation found in multiple-drawn materials, and that information is contained in an article now being pre-



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CIRCLE 7 ON READER-SERVICE CARD

pared for publication later this year.

The combination of Chromel/Alumel [T] in copper sheath is almost unheard of, and the conductors, of course, could be easily electrically resistance-annealed between multiple passes without damage to the copper. However, a more common construction is stainless alloy sheath and copper conductors, which are severely damaged by the multiple high temperature annealing operations necessary. This damage is obviated by SPS (single pass swaging).

Earle C. Smith, President
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[T] Hoskins Manufacturing Co.

Editor, I&CS:

Are reprints of Milton Laikin's article, "Optical Systems" (*Instruments and Control Systems*, March, 1961, p. 455) available?

By the way, is there an inconsistency in Mr. Laiken's statement about striae in mirrors (par. 2 in left-hand column on p. 455)? He speaks of using glass with a high-quality rating (A and AA) as regards striae, for high-quality mirrors and prisms. Presumably these grades mean low striae, for by the time he gets to grade C he is talking about condenser lenses—which of course are not very critical. Then he says, "Very low striae are not required in a mirror . . ." I would be very grateful if you could clarify the point. His statement may be correct, but I find the phrasing rather ambiguous.

Ch. H. Chandler, Manager
Electronic Process Development
Gillette Safety Razor Company
Boston, Mass.

The author replies:

You are quite correct in saying that striae-C is a lower grade than striae-A. By striae, we mean a variation in index of refraction of the glass. This is, of course, quite important for lenses and other parts where refraction occurs.

When I made the statement, "Very low striae are not required in a mirror," I was referring to a front-surface mirror where there is no refraction at all. Therefore, striae as such has no meaning here.

Pyrex generally has quite a bit of striae which thus makes it a rather poor material for refractive elements. However, for a mirror, its low coefficient of thermal expansion makes it ideal. The striae in it is only detrimental in that thermal expansion may

not be uniform, but Pyrex having a low coefficient of thermal expansion makes this effect rather small.

Milton Laikin
Scientific and Process Instruments Div.
Beckman Instruments, Inc.
Fullerton, Calif.

Editor, I&CS:

Some time ago I read an article in *I&CS* about the lag in training of highly skilled instrumentmakers.

Thought provoking, I was thinking of the instrumentmakers training that was established in the Netherlands as far back as 1901, in the Physics Department of the University of Leiden. It has been growing ever since, and as of now there are about a hundred trainees in their workshops at all times. As it is a five-year course, the graduates find themselves a good job in Industry or in other Universities every year. At least an equal number start their training each year. I was one of those graduates of that institution and for that reason I am completely informed on the administration of that course. The graduates have found a sound recognition in industry and elsewhere as highly-skilled instrument-makers. Advertisements for employment often state that a diploma of that institution is a requirement of all applicants.

A few years ago I made a semi-complete plan for somewhat similar training at the Physics Department of Yale University. Financial and time problems have been postponing the initiation of the project. The National Science Foundation, when approached, correctly stated that industries would profit most from such a training school for instrument-makers, and they therefore refused to make funds available through the Foundation.

Sizeable funds must be made available from some source, however, if the project is to get started on a favorable scale. Additional working space, machines and tools must be provided and extra instructors must be hired.

Since it might require considerable time to find large support, we plan to start with one or two trainees yearly in the existing workshops here, where 18 technicians already are regularly employed. Sufficient modern machinery will be available for those trainees who will have to work toward certain examinations that will certify their skill and theoretical knowledge. There is, of course, a lot more to it, and a lot more to say about it, but most important now is publicity on the need for such train-

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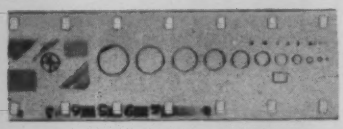
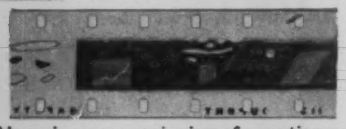
CIRCLE 8 ON READER-SERVICE CARD

NARROW-CHANNEL PHOTOGRAPHY

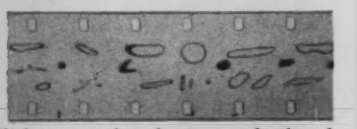
For people with the problem of photographing the interior of long, narrow channels, Kollmorgen has developed unusual devices capable of recording on film channels as narrow as 1/32 of an inch.



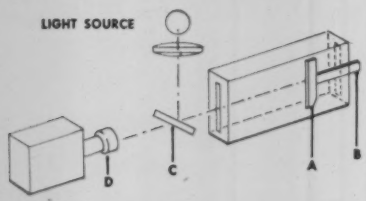
Above, actual size, is a test film of circles and numerals placed within a 1/32"-wide channel.



Above is a *panoramic* view of a continuous section of the same film . . . with marks enlarged 8x.



Pitting, corrosion, fracture and other defects of interior walls can be continuously recorded with full-dimensional accuracy . . . of exceptional value in quality control operations.



The secret of our insight: A highly precise 45° mirror (A), mounted on a reed (B), is inserted in one end of the channel. A beam splitter (C) directs a powerful light into the channel from the opposite end which is reflected by the mirror onto the sidewall. The photographic leg of the system receives the image from the channel mirror and through the beam splitter. A camera objective (D) focuses the image on the film. The channel is advanced by a carriage in precise synchronization with the advance of film. Result: a continuous, clear photographic record of the entire channel.

Various modifications of this device have been applied to channels up to six feet long. For longer and wider channels we have designed a miniature self-propelled camera, mirror and light source capable of presenting a continuous image on film with resolution sufficient to reveal scratches and hair-line cracks smaller than .010 inch.

If you need special insight on "inaccessible" interiors, or information on other unusual applications of optics/electronics/mechanics—let's talk it over.

Write Dept. 12-7

KOLLMORGEN CORPORATION
NORTHAMPTON, MASSACHUSETTS

CIRCLE 9 ON READER-SERVICE CARD

ing courses in this Country, and above all the necessary financial support. We are willing to undertake the job. Who is going to help us?

Adrian A. Disco,
Superintendent Physics and Observatory shops,
Yale University,
New Haven, Conn.

Editor, I&CS:

I am a young Engineer from Bombay (INDIA). I have been undergoing training with various firms in Britain, mostly connected with Steam Generation and efficient utilisation.

I am much interested in the Instrumentation and Automatic Control, for process variables, such as pressure, temperature, liquid-level, flow, ratio, combustion, etc., as applied to various industries for power and process, power stations, boilers, paper-mills, textile mills, laundries and allied process industries.

I am a regular reader of your magazine *Instruments and Control Systems*. In particular, I enjoy "Ramblings," and your special features such as "Process Control Systems," "New applications" etc. I have gained considerable knowledge.

Do you have a collection of these articles, particularly "Process Control Systems," application data applied to various process? I will be most grateful should you be kind enough to send me above, together with the booklet "The Best of Ramblings."

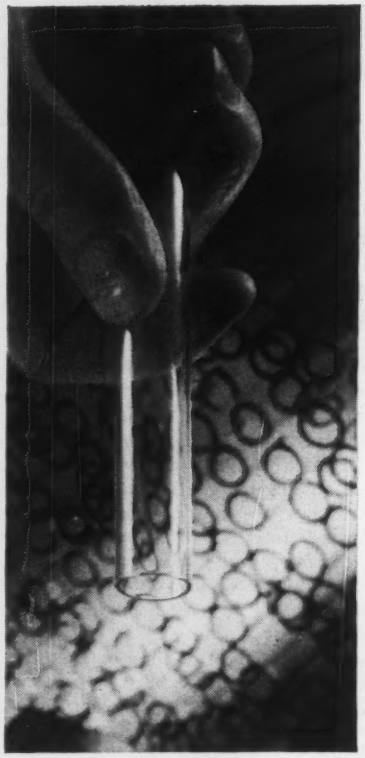
M. R. Desai
Gloucester, England, U. K.

The Best of Ramblings is available from The Hays Corporation, Michigan City, Indiana; our *Process Control Handbook*, with 60 Process Control Circuits, is available.

Editor, I&CS:

We are pleased to advise you our recent subscription to your magazine is already producing unexpected dividends, in the form of your *Buyer's Guide*. We have recently decided to expand our manufacturing activities, and this guide is valuable to a very considerable degree as an aid in locating special supply sources. I am only sorry we did not know about your most excellent publication earlier.

Thos. B. Strother, Pres.
Strother's Electronics-TV, Inc.
Richmond, Calif.



THIS TUBING CAN SAVE YOU MONEY

This special CORNING® flint glass tubing and rod give you ease of forming, strength, and topflight transparency. They are priced up to 50% lower than PYREX® tubing and rod. They are available immediately.

We developed CORNING brand 0088 flint glass just for the making of low-temperature-service tubing and rod. In uses near room temperature, it resists chemicals almost as well as PYREX brand glasses.

A statistical profile: coefficient of expansion, 92 x 10^{-7}; softening point, 700° C.; annealing point, 521° C.; strain point, 480° C.

We put this glass into apparatus tubing with outer diameters which range from 3 to 51 mm, in capillary and barometer tubing with inner diameters from 0.5 to 4 mm, and in rod with diameters from 3 to 12 mm. All are furnished in 48-inch lengths.

You can get any type in any quantity, quickly. For information on our entire tubing and rod line, write for Bulletin TBG-88.

CORNING GLASS WORKS
10007 Crystal St., Corning, N. Y.
CORNING MEANS RESEARCH IN GLASS

CIRCLE 10 ON READER-SERVICE CARD

Editor, I&CS:

I have recently read your book on strain gage instrumentation, and find it really excellent. Hope your future editions will cover our new high-output semiconductor strain-gage Micro-Sensors.

David T. Traitel
Electro-Optical Systems, Inc.
Pasadena, Calif.

It sure will—in fact, it will contain the article to be found on page 1064, June ICS.

Editor, I&CS:

Regarding Reader Inquiry A-6107:

The Meditron Division of Crescent manufactures a wide variety of high quality electromyographs. These include single and dual channel models, all of which have a recording system which utilizes magnetic tape. Ink-writing recorders may be used, but the frequency characteristics of muscle potentials are such that the magnetic tape is far superior. We are also equipped to build special multi-channel units for research work on special order.

Many other types of medical equipment are produced by Crescent and Meditron. These include nerve locators, cardiac defibrillators, muscle re-educators, ocular tonometers, dynamometers and other related equipment.

D. M. Parker
Medical Electronics Div.
Crescent Engineering & Research Co.
El Monte, California

Editor, I&CS:

I recently subscribed for your magazine *Instruments and Control System.* I received a copy of the 1960 Edition of *Handbook of Electrical Measurements,* a very valuable Handbook. In the short time that I have had this Handbook; many of my co-workers have evidenced a desire to obtain a copy. However, since I use my own copy constantly, I have been unable to circulate it for sufficient time for them to really become acquainted with its value.

Could I obtain an additional copy for the purpose of circulation among my co-workers? They can obtain their own copy by subscribing to the magazine, but if I could circulate a copy, the end result would be many subscriptions for your magazine. I would be happy to do this as I consider your magazine to be so useful.

Harry M. Baldwin
Glendale, Calif.

Solve

HIGH TEMPERATURE

measurement problems beyond the scope of conventional pyrometers...

PYRO-650*

Fully Automatic Optical *Brightness* Pyrometer

If you have been using a manually operated optical pyrometer, but now need an instrument that operates continuously, and makes possible both recording and controlling, the PYRO-650 Automatic Optical Brightness Pyrometer is designed for you.

PYRO-650 measures temperature automatically and continuously over a wide range from 1200°F to 6300°F; 650°C to 3500°C. Since it is fully automatic, any possibility of human error is eliminated . . . reliability is assured. PYRO-650 makes rapid and accurate measurements . . . essential in physical property studies of exotic metals, cermets, graphites and refractories at high temperatures. PYRO-650 gives you a continuous, permanent record of measurement . . . important in short duration temperature studies and necessary where certification of temperature test data is a requirement.

The fully automatic PYRO-650 Optical Brightness Pyrometer makes use of industry's many years of technical knowledge and experience . . . and takes the next logical step beyond the manual optical pyrometer.

Write today for Bulletin No. 614, describing PYRO-650 in full detail.

*Trademark of Instrument Development Laboratories

INSTRUMENT DEVELOPMENT LABORATORIES, INC.
Subsidiary of Royal McBee Corporation
61 MECHANIC STREET, ATTLEBORO, MASS.

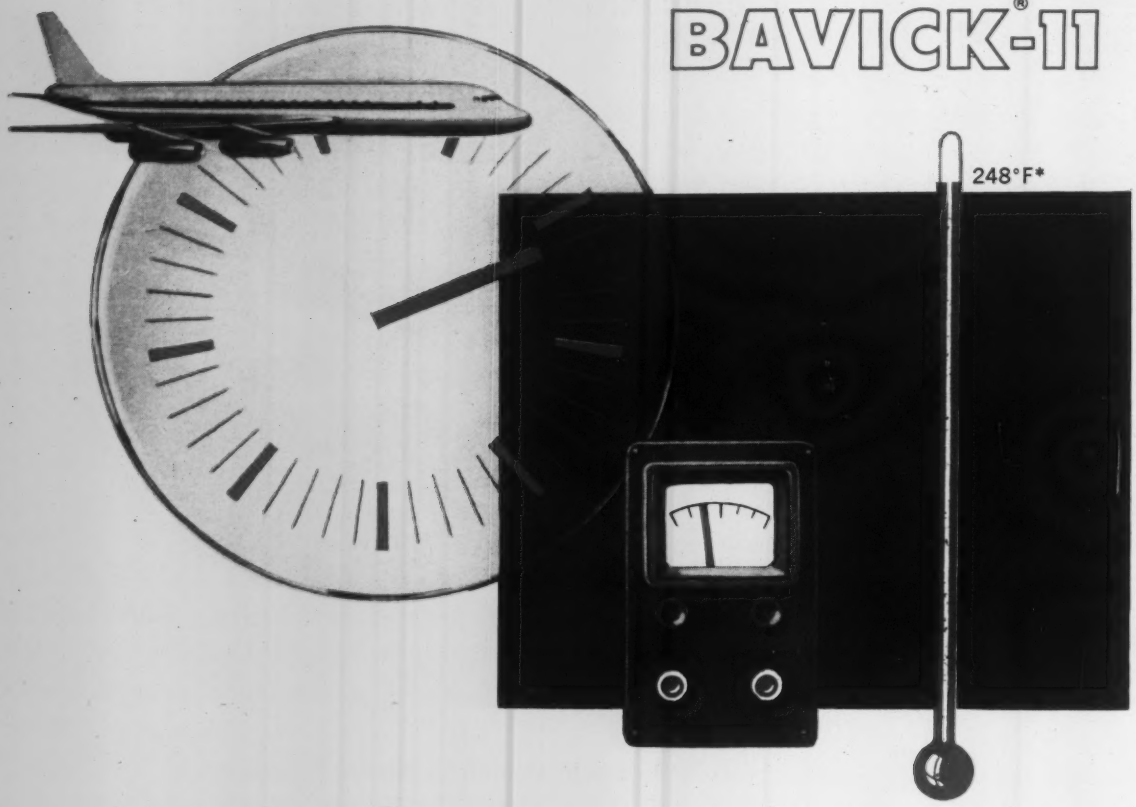
Also manufacturers of PYRO-EYE® Two-color Optical Pyrometer

CIRCLE 11 ON READER-SERVICE CARD

Highest heat resistance

of any water-white transparent thermoplastic

BAVICK®-11



Ideal for dial faces and windows, pointers, indicator lights, etc.

Bavick-11 is the *first* and *only* acrylic-type thermoplastic to offer the unique combination of properties described below. Bavick-11 is being used in important military instrument applications.

1. HIGH HEAT RESISTANCE. No warping or distortion at temperatures up to 248°F. No crazing or loss of transparency from extreme thermal shock.

2. SOLVENT / CHEMICAL RESISTANCE. No crazing or loss of transparency in chemical atmospheres—unaffected by most acids and alkalies, alcohols, silicones and aliphatic hydrocarbons.

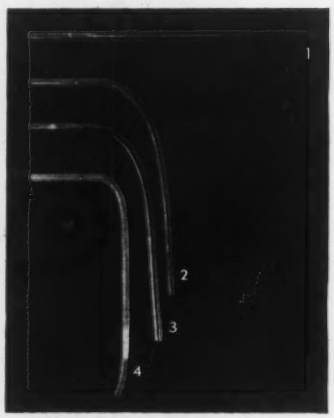
3. UNUSUAL OPTICAL PROPERTIES. Water-white clarity and high index of refraction. Ideal for "piping" light, edge lighting, etc.

4. RESISTS BREAKAGE. Strong, tough—resists mechanical shock.

5. EXTREME WATER / STEAM RESISTANCE. Transparency unaffected by continuous immersion in boiling water. Shape characteristics unaffected by steam at 5 p.s.i. pressure.

Bavick-11 is particularly valuable for aircraft, military, laboratory and electronic instruments. Dial faces and windows are crystal clear, strong, and withstand extremely high temperatures. Bavick-11 "pipes" light through dial pointers, is easily colored for indicator lights, and resists shock. Bavick-11 can be injection or compression molded, extruded, machined, cemented, and decorated.

These properties make Bavick-11 ideal for many other uses . . . in home appliances, automotive lighting, optical lenses, etc.



Effect of temperature on straight extruded rod at 240°F. for 72 hours. All rods clamped horizontally at one end.

1. BAVICK-11
2. Commercial Styrene-Acrylonitrile
3. Commercial Methylmethacrylate
4. Commercial Methylstyrene-Acrylonitrile

May we send you literature about new, heat-resistant Bavick-11? Write on your letterhead to Dept. ICS.

Plastic Division **J. T. Baker Chemical Co.**
Phillipsburg, New Jersey

J.T.Baker CHEMICAL

®Registered Trademark *ASTM Heat Distortion D648 264 psi

CIRCLE 12 ON READER-SERVICE CARD

HOKE **Flow Sheet** 5

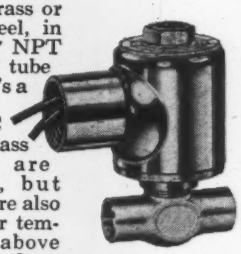
HOKE REPORTS ON FLUID CONTROL

WE'VE TOSSED A NEW BALL INTO AN OLD GAME

A VALVE NAMED "DESIRE"

With apologies to Tennessee Williams, we really have produced a Solenoid Valve line based on *your* desires. We surveyed all the solenoid valve users we could find to determine what *you* wanted. The result is Hoke's "User Designed" Series 90 and 95, two-way and three-way, direct-acting solenoid valve line.

Thanks to you, we have much to brag about. Here's what we have been saying about these new valves: lightest weight – smallest size – no-hum operation – lowest temperature rise – lowest power consumption – stainless steel plunger – silver AC shading coils – easiest installation – packless construction – 360° rotatable housing – operates in any position.



We make them of forged brass or stainless steel, in ⅛" and ¼" NPT size or JIC tube ends. There's a variety of AC and DC voltages. Class "A" coils are standard, but Class "H" are also available for temperatures above 212°F. For those with high insurance rates, we can supply explosion proof coil housings.

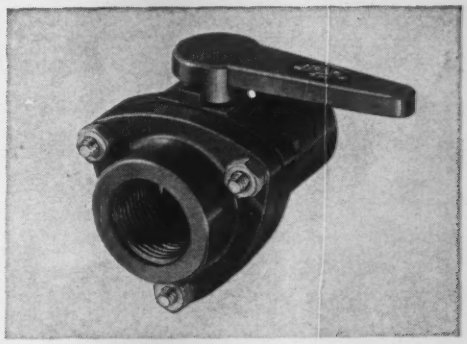
Now that we've bragged a bit, we must also apologize for our premature enthusiasm. We were so excited about this product that we stirred up a hornet's nest of interest before we were ready to deliver in quantity. Shipments were slow at the start, but now we can have any reasonable quantity of these "desirable" solenoid valves "on-stream" in your plant when you want them.

There's only one way to get conclusive performance proof – buy a valve. Ask for Bulletin SV-4-61.

A STEADY FLOW OF FACTS!

Further flow features, and interesting technical topics are carefully covered in Hoke's technical publication, the FLOW SHEET. It's free, but worth millions! To get the full benefit of our engineering and editorial efforts six times a year, mark your "X" in the proper box.

The technique of molding polyvinyl chloride into ball valve parts is old hat. Even the unplasticized compounds of type I PVC have been kicked around for a while (with minor successes). But until now, no one has booted the ball for a goal.



Perseverance, determination, and the pursuit of economic reward have prompted us to offer a line of ball valves molded of the toughest grade of type I, unplasticized PVC. There are no foreign agents to contribute to a corrosive demise, even in most caustic services. It even meets the proposed new ASTM specification and has a tensile strength of 8500 psi. Those who have had PVC piping problems will profit from the new molding process that gives these Hokes dimensional stability and very high impact strength. Sensitive systems, human and otherwise, are safe from contamination – they're absolutely non-toxic. We've set 140°F. as the operating temperature limit, but occasional excursions to 160°F. won't do any harm.

All standard models are supplied with a concentric hole drilled thru the ball. They can be heat welded, or solvent bonded right in the line. Piping hook-up is even simplified by their coupling-like assembly. Your assistant can fit each half of the valve to a pipe end, then reassemble the valve without having to turn the pipe. Pressures to 125 psi are duck soup for these valves.

A maintenance man's delight, they can be cleaned and have their seats changed without leaving the pipe. Their light weight makes them ideal for use on long, unsupported spans of pipe.

Size-wise, we're offering them in ½, ¾, 1, 1½, 2, and 3 inch sizes, all NPT female connections.

You will command the eternal admiration of your colleagues when you install these valves. Be the first to show your rightful status by ordering a shiny new Hoke polyvinyl chloride ball valve. If pride of ownership hasn't motivated you at this point, the mere fact that you are behind the scientific times should move you to find out more.

It isn't necessary to tell us why you want the additional information. Just check the coupon below. We'll forward the facts in a plain, brown envelope.

'61 PRODUCT PARADE

You'd be surprised at some of the screwball ways our valves have been used (to decided advantage, of course). Hoke distributors are armed to their maxillary third molars with this method madness and will redesign your systems (incorporating solenoid valves and PVC ball valves) at the drop of a postcard. Check the PRODUCT PARADE box.

Hoke's Performance Guarantee — *Every Valve Leak-Tested!*

HOKE, INCORPORATED
31 Piermont Road, Cresskill, N. J.

Send me complete information on the Hoke products checked below:

- ☐ PVC Ball Valves
- ☐ Solenoid Valves
- ☐ Product Parade
- ☐ Flow Sheet
- ☐ Complete Catalog GC960

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

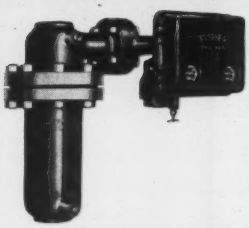
SEE OUR CATALOG IN SWEETS PRODUCT DESIGN FILE

CIRCLE 13 ON READER-SERVICE CARD

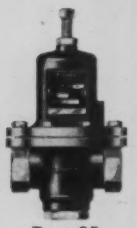
Need controls in a hurry?

Type 657
Control Valves

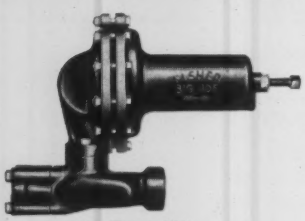
Type 4150 and 4160
Wizard II Pressure Controllers



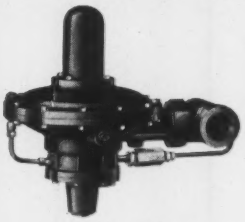
Series 2500-249 and 259B
Level-Trols—Cage Sizes 14" & 32"



Type 95
Pressure Reducing Valve



Type 630
"Big Joe" Field Regulator



Series 99
Multi-Purpose Gas Regulator

Call Fisher for 36-hour Service

Write, wire, phone or TWX for "supermarket" service direct from factory or factory-trained engineers in these strategically located offices:

AMARILLO
Vinson Supply Company

ATLANTA
J. M. Smither & Company

BALTIMORE
The Rhodes Controls Company

BIRMINGHAM
Joseph W. Eshelman & Company

BOSTON
Clarence B. Petty & Company

BUFFALO
R. M. Newell Company

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SEATTLE
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Northern Columbia Process Equipment Company

WICHITA-LIBERAL
Sullivan-Mears Company

WINNIPEG
Mechanical Valve & Engr. Spec.

Offices listed in red maintain field stock.

An Example of Fisher "Supermarket" Service . . .

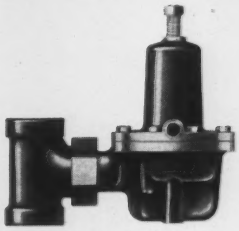
It was on a Friday morning when the Fisher representative in Oslo, Norway, called the plant in Marshalltown with an emergency order. Selection was made from the Fisher "Supermarket" stock and shipped immediately. The control was actually in the customer's plant in Oslo on the following Monday.

Fisher Governor Company, Marshalltown, Ia.
Plants in Woodstock, Ont., Rochester, England. Butterfly Valve Div.: Continental Equipment Co., Coraopolis, Pa.

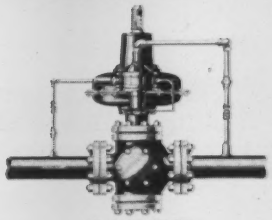
If it flows through pipe anywhere in the world ...chances are it's controlled by.....

FISHER® Controls SINCE 1880

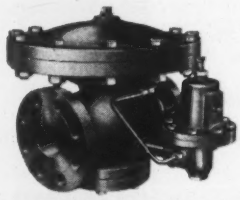
Series 470
P.O.P. Control Valves



Series 620 and 621
Farm Tap Regulators



Series 298T
Gas Regulators



Type 92B Pilot Operated
Steam Reducing Valve

Type 655-A
Pressure Regulator

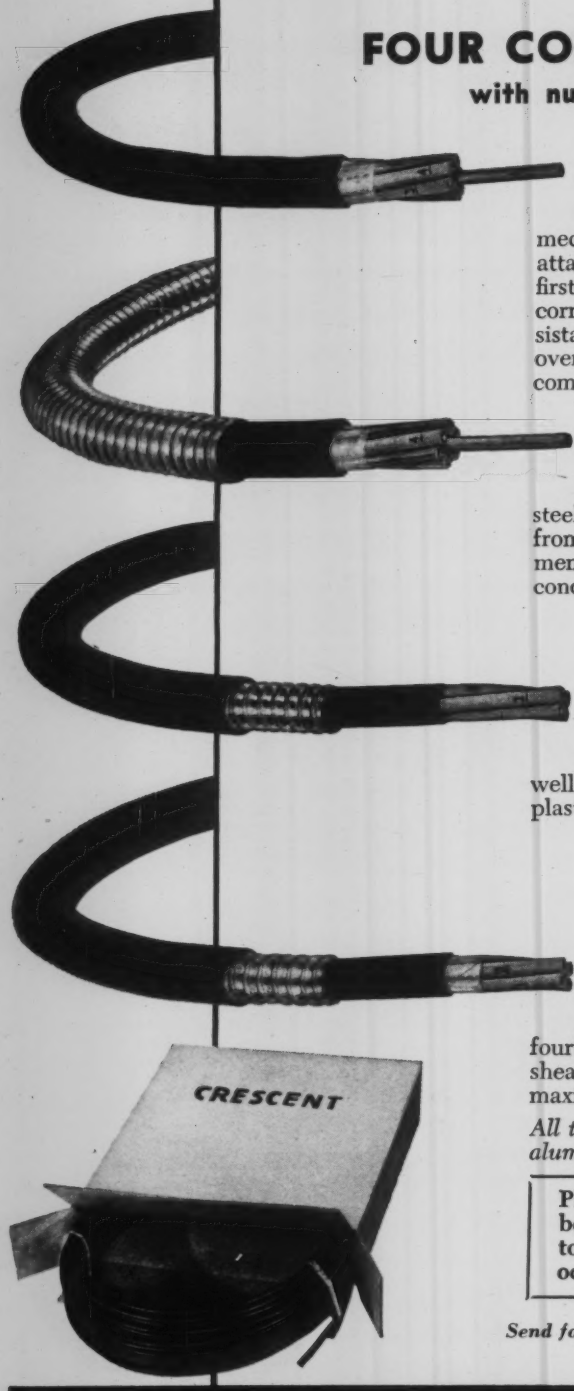
Series 67FR
Combination Filter Regulator

CIRCLE 14 ON READER-SERVICE CARD

The Answer to Your Corrosion Problems

CRESCENT ARMORED MULTITUBE®

*Reg. Trade Mark



FOUR CORROSION-RESISTANT TYPES

with numbered Tubes for easy identification

TYPE CT

In damp or corrosive locations where a moderate degree of mechanical protection to the tubes is required, as in troughs or attached to sheltered building surfaces as supporting means, the first construction illustrated is recommended. It employs a tough, corrosion-resistant polyvinyl chloride thermoplastic sheath, resistant to water, acids, alkalies, oils and most chemicals, applied over CABLED copper tubes. The sheath will not support combustion.

TYPE CTA

Gives corrosion protection to the tubes, and the galvanized steel armor protects the tubes and polyvinyl thermoplastic sheath from mechanical injury during and after installation. Recommended for direct burial in concrete or pulling into underground conduits.

TYPE CAT

Gives corrosion protection to the galvanized steel armor as well as the tubing. Recommended where the polyvinyl thermoplastic sheath will not be subject to mechanical injury.

TYPE CTAT

Combining the advantages of Types CTA and CAT, the fourth type illustrated has the polyvinyl chloride thermoplastic sheath both under the armor and over the armor, thus providing maximum mechanical and corrosion protection.

All these corrosion-resistant types can be furnished with copper, aluminum and polyethylene tubes, and up to 37 tubes.

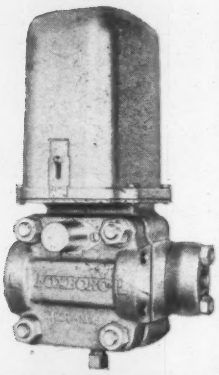
Plastic Coated Single Tubes, copper or aluminum, should be used to give corrosion protection to all single lines up to the final tube fitting, where trouble from corrosion may occur.

Send for Bulletin 960-A giving complete information and engineering data

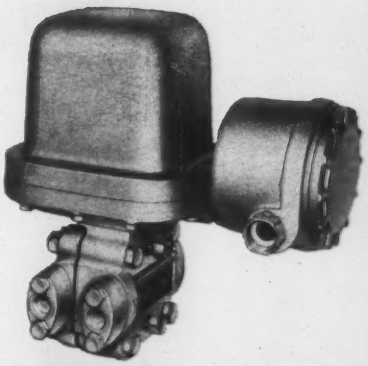
CRESCENT INSULATED WIRE & CABLE CO., INC.

TRENTON, NEW JERSEY

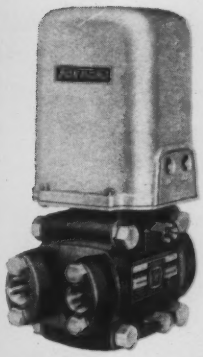
CIRCLE 15 ON READER-SERVICE CARD



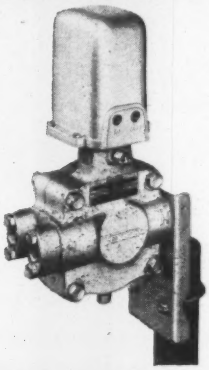
FOR ABSOLUTE PRESSURE



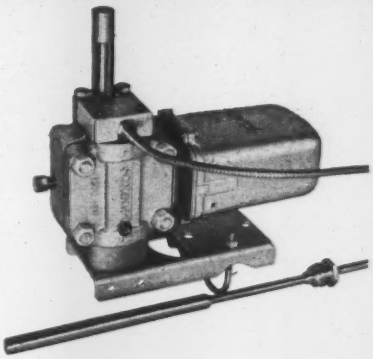
FOR ELECTRONIC TRANSMISSION



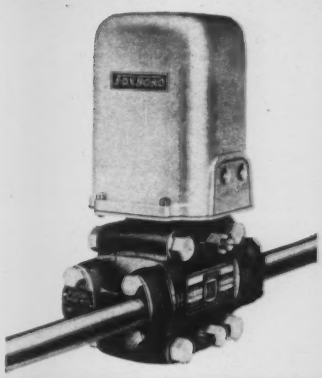
FOR PROCESS FLOWS



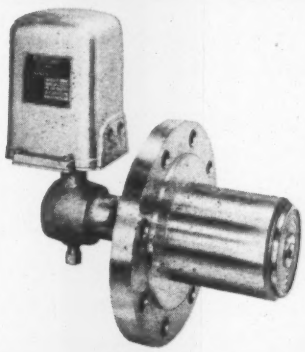
FOR LOW RANGES



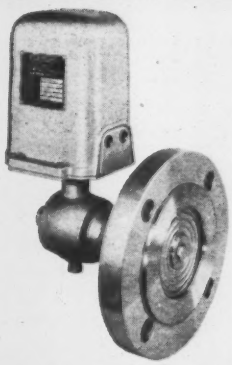
FOR SAMPLE FLUID COMPARISON



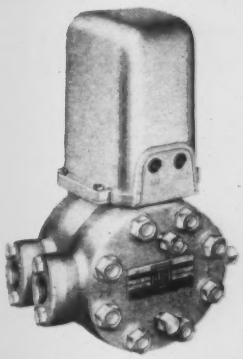
FOR EXTREMELY SMALL FLOWS



FOR FLUSH TANK MOUNTING



FOR DIRECT TANK MOUNTING



FOR HIGH PRESSURES

these Foxboro d/p Cell* Transmitters are related ...in design – in accuracy – in savings for you

Nine different process applications — all using the same basic Foxboro d/p Cell.

Consider the advantages of this standardization for your plant. Universal calibration techniques — simplified training of personnel — reduced stocks of component parts. Plus the highest sustained accuracy of measurement and transmission under the most punishing operating conditions.

Pneumatic or electronic, why not standardize on industry's standard — the Foxboro d/p Cell Transmitter. Write today for descriptive literature. The Foxboro Company, 467 Neponset Avenue, Foxboro, Massachusetts.

Reg. U. S. Pat. Off.

FOXBORO

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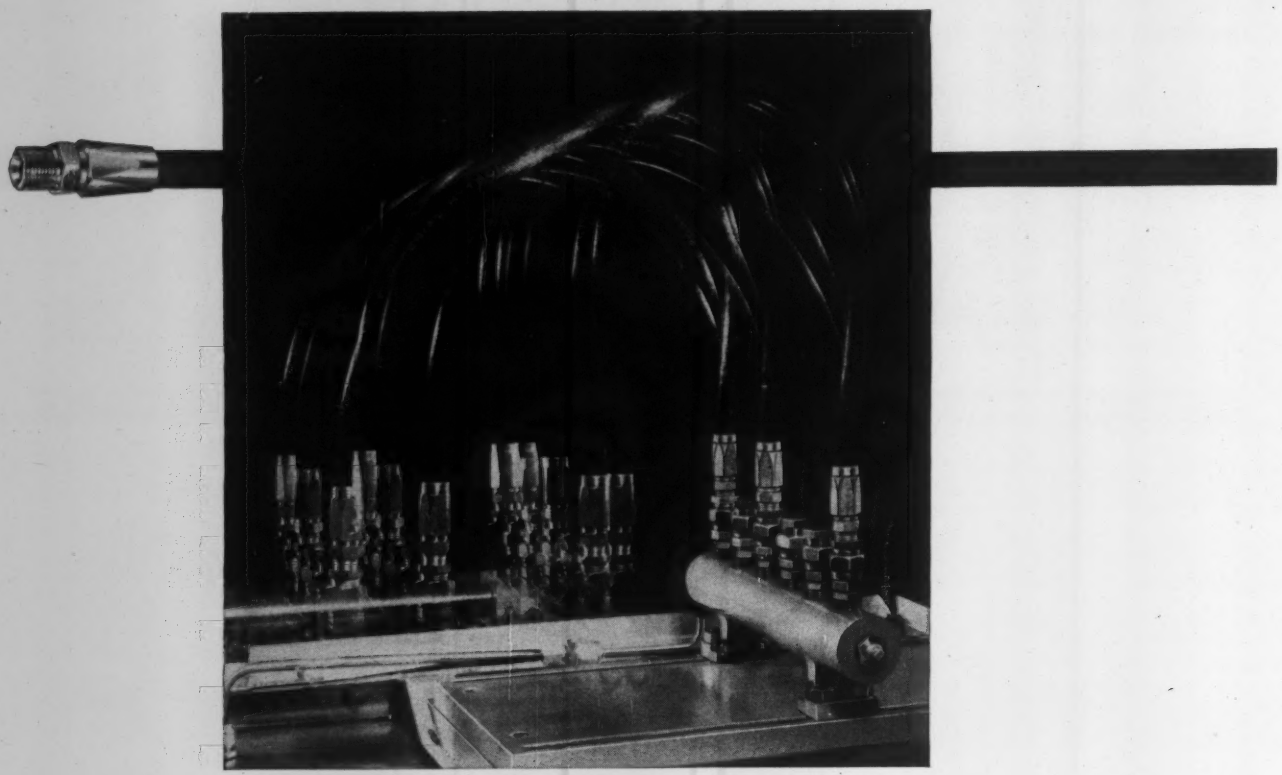
CIRCLE 16 ON READER-SERVICE CARD



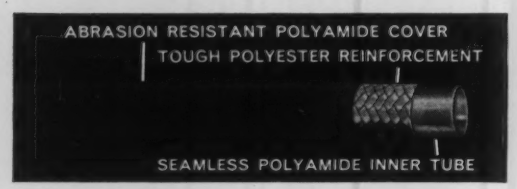
Hytron® hose delivers

7 TIMES THE FLEX LIFE

of wire braid hose

No need to pamper Hytron Hose. It lasts long, saves money on many applications. Hytron also has a wider range of uses than wire braid hose because it is more compatible to different fluids—mineral or synthetic fluids having a water or phosphate ester base.

Extra-long flex life and compatibility are *only two* of the outstanding advantages of Hytron Hose. For more information, see the next page. And write for detailed report and test results—Bulletin NEPR-500.



HYTRON

IMPERIAL EASTMAN

Imperial-Eastman Corporation General Offices: 6300 West Howard Street, Chicago 48, Illinois

Imperial-Eastman Corporation (Canada) Ltd., Barrie, Ontario • Imperial-Eastman, S.A., Apartado Postal 26544, Mexico 13, D.F.

CIRCLE 17 ON READER-SERVICE CARD

HYTRON

solves problems, meets more needs, cuts costs

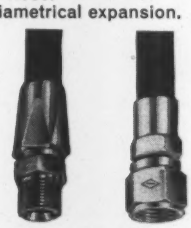
Hytron Hose, made with a seamless, extruded inner tube of special virgin polyamide, has a high-tensile-strength polyester braid reinforcement, plus extruded polyamide cover. Its strength compares with wire braid hose—its *additional* features open new design opportunities in hydraulic and pneumatic systems.

Compatibility=more uses

Hytron Hose is compatible with mineral or synthetic fluids having either water or phosphate ester base. Thus, you can use this *one* hose for *more* applications. Wherever you use S.A.E. 100R1 wire braid hose, Hytron should be considered.

Major advantages

- 7.2 times the flex life of wire braid hose.
- 2½ times more abrasion-resistance than rubber. High resistance to mildew, heat, sunlight, chemicals.
- Burst pressures from 9000 to 12,000 psi, depending on hose size and temperature. Temperature ranges from −40° to 250° F.
- Available in long lengths—up to 1000 ft. Sizes to ¾ in.
- 60% lighter weight than wire braid rubber hose.
- Low diametrical expansion.



Hytron Hose furnished as factory-made assemblies with permanently attached couplings, or with easy-to-install, re-usable couplings, in a wide range of sizes and styles.

HOSE

IMPERIAL — EASTMAN

IGS EVENTS

August 15-18

Testing Conference—Tappi Montreal, Que., Can., Queen Elizabeth Hotel. For information write Technical Association for the Pulp and Paper Industry, J. Winchester, 360 Lexington Ave., New York, N. Y.

August 22-25

Western Electronics Show and Convention (WESCON), Cow Palace, San Francisco, Calif. For information write Don Larson, WESCON manager, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

August 28-30

21st Annual Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, W. Va. For information write Prof. R. E. Hanna, University of West Virginia, Morgantown, W. Va.

August 30 to September 1

Third Annual AIME Semiconductor Conference, Ambassador Hotel, Los Angeles, Calif. For information write J. O. McCaldin, 11601 Montana Ave., Los Angeles 49, Calif.

September 5-8

Eleventh National Chemical Exposition, International Amphitheatre, Chicago, Ill. For information write Chicago Section American Chemical Society, 86 E. Randolph St., Chicago 1, Ill.

September 11-15

Third International Congress on Cybernetics, Namur, Belgium. For information write Secretary, Association Internationale de Cybernetique, A.S.B.L., rue Basse-Marcelle, 13, Namur, Belgium.

September 11-15

ISA Fall Instrument-Automation Conference and Exhibit, Memorial Sports Arena and Biltmore Hotel, Los Angeles, Calif. For information write William Kushnick, Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

September 20-21

Joint Industrial Electronics Symposium, IRE, ISA, AIEE, Bradford Hotel, Boston, Mass. For information write H. O. Painter, Jr., General Radio Co., West Concord, Mass.

September 24-26

International Congress of Automation, Turin Polytechnic, Turin, Italy. Write Secretary, Associazione Nazionale Italiana per l'Automazione (A.N.I.P.L.A.), Piazza Belgioioso 1, Milan, Italy.

FACT

Flexible Automatic Circuit Tester

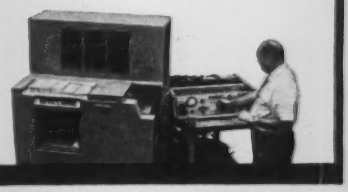
Cut the cost of circuit testing

Eliminate the costs of developing special purpose test equipment for each production program! Cut the time required to verify the wiring integrity of electrical assemblies! Reduce the amount of valuable floor space required for circuit testing! □ With the Hughes-developed **FACT**—short for Flexible Automatic Circuit Tester—you get a mobile, *general purpose* test unit that quickly detects and isolates continuity and high potential faults. **FACT** is a high capacity unit—it can program complete tests on an unlimited number of circuits. **FACT** cuts down programming time dramatically—it uses standard IBM systems. **FACT** substantially reduces trouble-shooting time. **FACT** is self-calibrating and self-testing—thereby substantially increasing the confidence level of the circuit test. □ **FACT** is production proven and available today. With three different **FACT** models (2 card programmed and 1 tape programmed) Hughes can meet every circuit testing problem. Inquire today. Write to L. W. Risner, Hughes El Segundo, L.A. 45, California. Or, better yet, call him at ORegon 8-0361. Ext. 1652.

Creating a new world with Electronics

HUGHES

HUGHES AIRCRAFT COMPANY



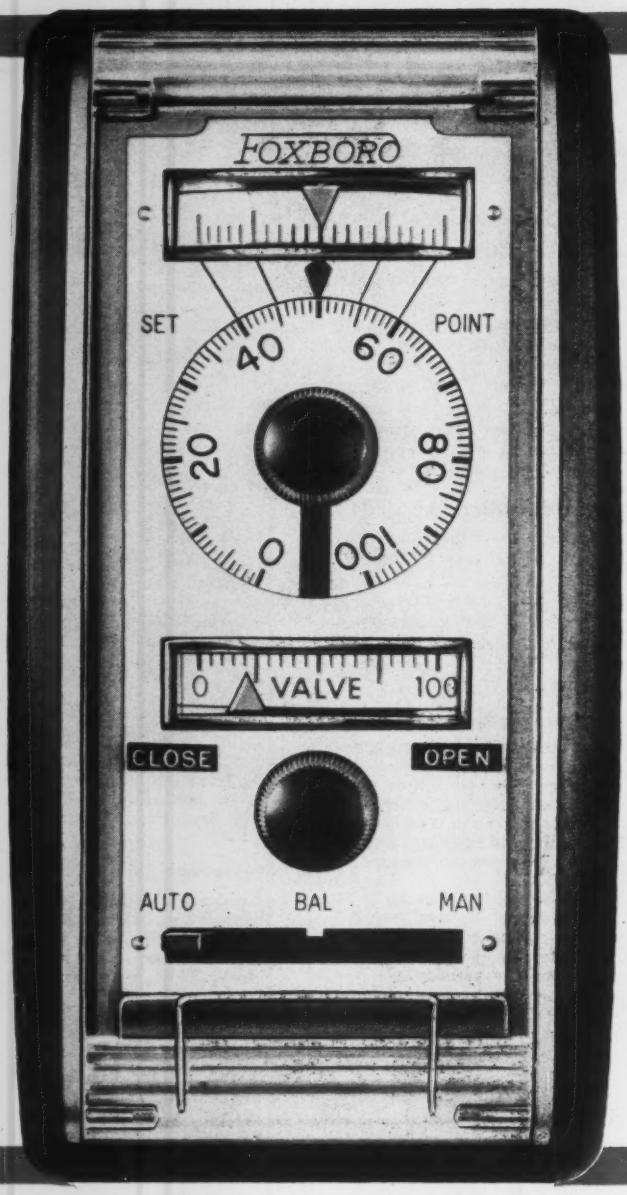
CIRCLE 18 ON READER-SERVICE CARD

Measurement deviation...

plus indication...

plus valve position...

you get them all with this **Foxboro electronic control station**



Shown here actual size →

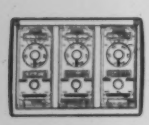
One 3″ x 6″ panel station containing all control and supervisory functions — that's the Foxboro Electronic Consotrol* Controller. All d-c input — all d-c output — all solid state. Operates completely independent from recording.

And look at these other features:

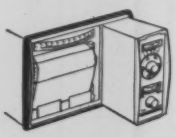
- measurement and deviation indicator gives continuous indication of process measurement as well as showing the deviation from set point.
- calibrated set point dial, with 4¾″ scale, used with deviation indicator for readability of ½% full scale.
- valve position indicator for continuous, horizontal-scale indication of valve opening.
- simple auto-manual transfer switch for smooth, bumpless transfer.

Foxboro electronic Consotrol control stations are available for cascade, ratio and auto-selector systems. Ask your Foxboro Field Engineer about them — or write for Bulletin 21-10. The Foxboro Company, 467 Norfolk St., Foxboro, Massachusetts.

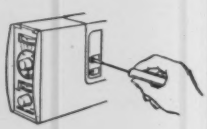
Reg. U. S. Pat. Off.



Standard 9″ x 6″ housing holds 3 control stations, or 1 station with a companion recorder.



Controller and recorder each slide out from panel for easy servicing.



Proportional — reset — derivative: all adjusted from the front.

FOXBORO
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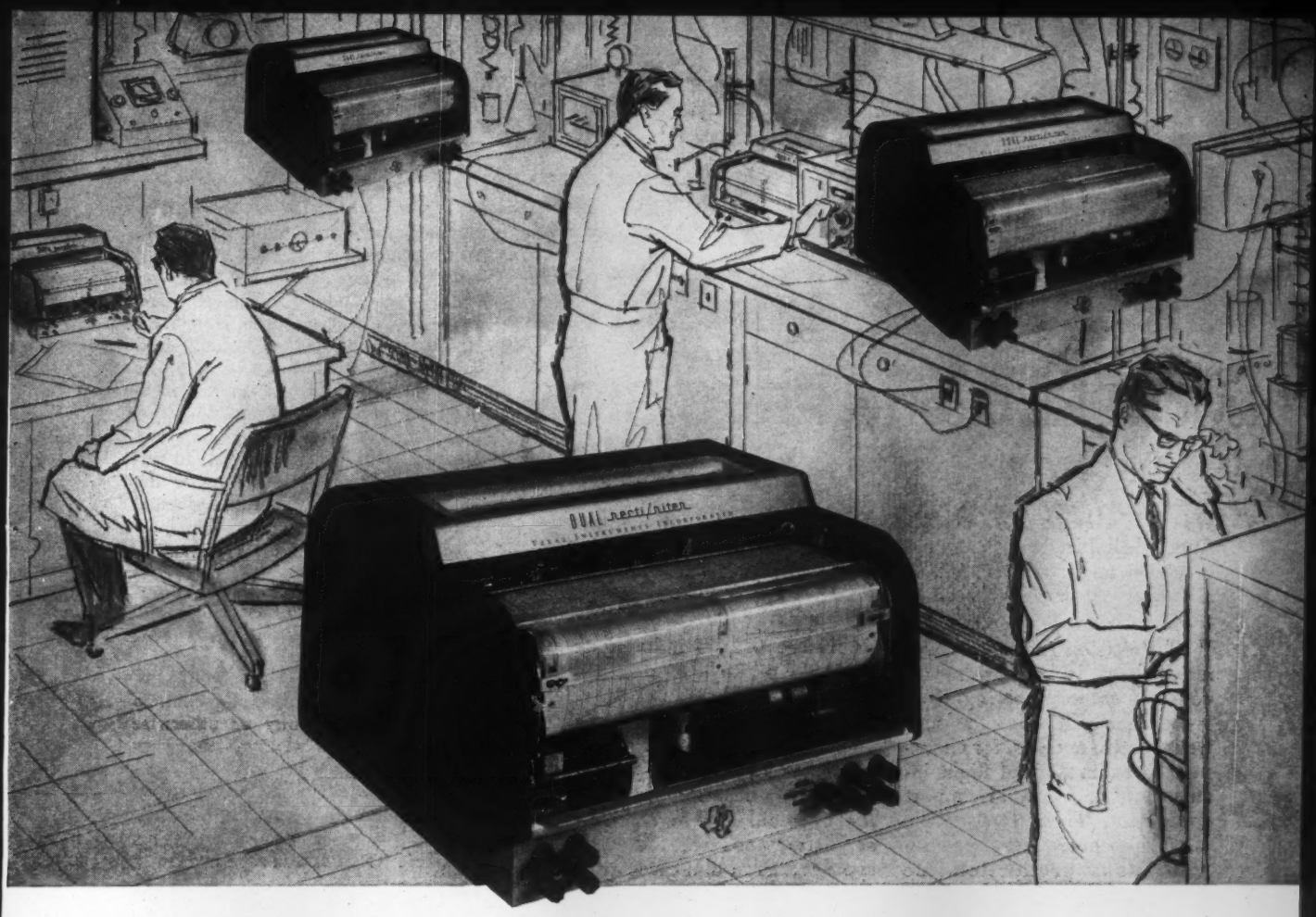
CIRCLE 19 ON READER-SERVICE CARD



operator convenience makes the recti/riter® recorder preferred for laboratory use

The *recti/riter* recorder has become the *accepted* laboratory recorder—is preferred for the exacting tasks of laboratory applications. The portable *recti/riter* is the only galvanometric rectilinear recorder designed specifically as a bench-top instrument with all routine controls and adjustments located up front for extra convenience. The "writing desk" chart carriage permits operators to make the extensive notations usually associated with laboratory use while the instrument is recording.

Ruggedized die-cast construction results in an instrument that can "take it"—yet removal of the one-piece dust cover makes every working part completely accessible and removable without further disassembly. Every *recti/riter* carries a one-year full service warranty.

There is a *recti/riter* to fit your particular requirements—single and dual channel, portable and flush-mounting models . . . each available in the widest selection of standard ranges in the industry.

Two-Cycle Pen Response

d-c Milliampere Ranges.....½ ma to 100 ma
a-c Ampere Ranges.....0.25 amp to 25 amp
d-c Ampere Range.....100 mv for use with standard shunts

Expanded Scale a-c Voltage Ranges
80-130 V, 160-260 V, 320-520 V
a-c and d-c Voltage Ranges.....10 V to 1000 V
Frequency Ranges.....50, 60, 400 cps

Five-Cycle Pen Response

d-c Milliampere Ranges.....2.5 ma to 125 ma

Special options and accessories further expand the versatility of *recti/riter* recorders. Write now for complete information on this *accepted* laboratory recorder line.

APPARATUS DIVISION
PLANTS IN HOUSTON
AND DALLAS, TEXAS

TEXAS INSTRUMENTS
INCORPORATED
3609 BUFFALO SPEEDWAY
P. O. BOX 6027 HOUSTON 6, TEXAS

CIRCLE 20 ON READER-SERVICE CARD

MEASURE ABSOLUTE PRESSURES

with SPEED and PRECISION

With Wallace & Tiernan Aneroid Dial Indicators you get precision and fast response in all types of absolute pressure work.

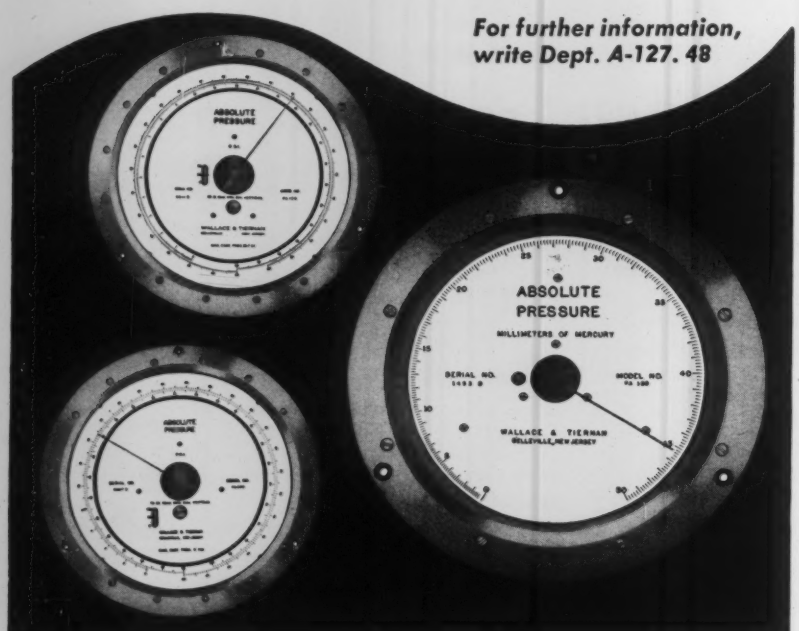
W&T Precision Indicators have many uses in research and development engineering. One is ideal for calibrating pressure transducers; another, for checking the calibration of flight instruments and ground support equipment. These instruments also keep constant check on continuous production-line work.

A W&T Absolute Pressure Gauge on the job means:

- ★ Accuracy 0.1% to 0.33%
- ★ Sensitivity 0.01% to 0.2%
- ★ Range 0.1-20 mm Hg to 0-500 p.s.i.a
- ★ No corrections
- ★ Light weight, small size

The accuracy of W&T Absolute Pressure Indicators approaches that of liquid columns... higher sensitivity assures faster response... large dial gives quick reading.

For further information, write Dept. A-127. 48



WALLACE & TIERNAN INCORPORATED

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CIRCLE 21 ON READER-SERVICE CARD

ICS BOOKS

Error Correcting Codes, by W. Wesley Peterson [c1961] Massachusetts Institute of Technology, the M.I.T. Press and John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y., 285 pp., 9″, clothbound $7.75. This is the first book to be devoted exclusively to error-detecting and error-correcting codes for information-transmission and storage systems. Of special interest to information theorists, teachers of the theory, data-transmission engineers, and computer engineers.

CIRCLE 186 ON READER-SERVICE CARD

A Guide to Technical Literature Production, by Emerson Clarke [1961], T W Publishers, Box 152, River Forest, Ill., 192 pp., 9″, paperbound $3.00. This engineering support service book will be of great help to all who create buy or otherwise produce technical writing, from government contractors, over engineering management and engineers, to publications managers, technical writers and editors, etc.

CIRCLE 187 ON READER-SERVICE CARD

Directory of Firms, Their Buyers and Specifying Engineers, Industries Publishing Company, P. O. Box 621, Culver City, Calif., 130 pp., 9″, clothbound $25.00. Lists 1800 buyers and 1500 specifying engineers in the aircraft, missile, space, and electronic industries and the military in the eleven Western States. Names of firms and addresses also are given.

CIRCLE 188 ON READER-SERVICE CARD

Silicon Zener Diode and Rectifier Handbook [c1961] Motorola, Inc., Semiconductor Products Div., 5005 East Mcdowell Rd., Phoenix, Ariz. 182 pp., 8½″, paperbound $2.00. Handbook, after dealing in several chapters with theory and design characteristics of the named semiconductors, discusses many applications without claim of an encylopedic coverage.

CIRCLE 189 ON READER-SERVICE CARD

Digital Computer Fundamentals, [c1961] Burroughs Corp., Military Field Service Div., Burroughs Dr., Radnor, Pa., 512 pp., 11″ paperbound $5.50. Written as reference source for computer course, book in 24 chapters treats four types of transistor logic systems and the vacuum logic system.

CIRCLE 190 ON READER-SERVICE CARD

Mathematical Handbook for Scientists and Engineers, by Granino A. Korn and Theresa M. Korn, [c1961] McGraw-Hill Book Company, Inc., New York 36, N. Y., 943 pp., 9″ clothbound $20.00. Reference to definitions, theorems and formulas in analytical geometry, calculus, vector analysis, integrals, Fourier analysis, Laplace transformations, differential equations, Boolean algebra, tensor analysis, probability theory, random processes, correlation functions, numerical computation, and finite-difference methods.

CIRCLE 191 ON READER-SERVICE CARD

Partial Differential Equations and Continuum Mechanics, edited by Rudolph E. Langer [c1961], The University of Wisconsin Press, Madison, Wis., 397 pp., 9″, colthbound $5.00. Consists of 19 lectures delivered at an international conference at the Mathematics Research Center, Univ. of Wis., June 7-15, 1960, also abstracts of 45 papers presented at this conference.

CIRCLE 192 ON READER-SERVICE CARD

Progress in Non-Destructive Testing, Vol. 2, edited by E. G. Stanford and J. H. Fearon, [c1960] Heywood & Co. Ltd., The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 250 pp., 9¾″, clothbound $12.00. Volume continues reports on progress made in relating properties of materials to each other and to structural factors which produce them, and surveys principal methods of flaw detection.

CIRCLE 193 ON READER-SERVICE CARD

Theory of Thermal Stresses by Bruno A. Boley and Jerome H. Weiner, [c1960] John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y., 586 pp., 9″, clothbound $15.50. Book contains broad account of all presently available theoretical techniques using thermodynamics, heat-transfer theory, elasticity and inelasticity as foundations. Methods of practical thermalstress analysis are presented.

CIRCLE 194 ON READER-SERVICE CARD

Electronic Business Machines edited by J. H. Levenson, [c1959] Dundee Technical College; Philosophical Library Inc., 15E. 46th St., New York 16, N. Y., 272 pp., 8¼″, clothbound $15.00. Work contains three main sections: Programming for business purposes; business management and electronic data processing; and computer equipment and applications. Aimed at business executives, accountants, etc.

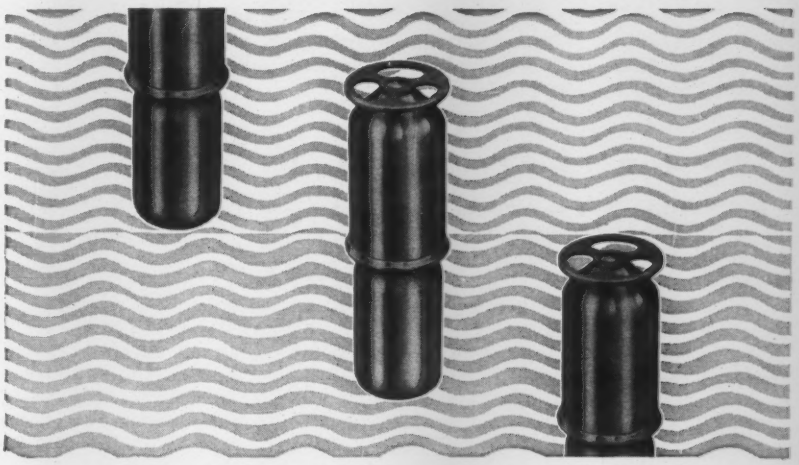
CIRCLE 195 ON READER-SERVICE CARD

Now you can mix or match ROTAMETER

capacities, pressure drops, prices

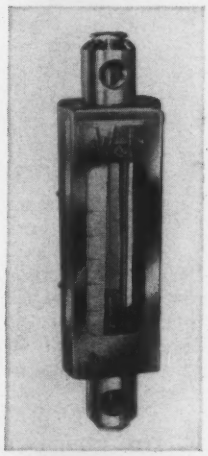
with the *new*

W&T VAREA-METER



Now you can have a useable kind of adaptability with Wallace & Tiernan's complete new line of Varea-meters. Deeply overlapping capacities and integrated tube-float combinations let you pinpoint capacity exactly. You get a truly job-proportioned rotameter.

Eight floats per tube size give a wide capacity selection. And Varea-meter capacities overlap 50% from meter size to meter size. For any given capacity you get a choice of two sizes. The larger gives you less pressure drop; the smaller costs less.



Size for size, Varea-meters give you more capacity than any other rotameter. A new float design and increased tube taper allow more throughput. You specify a smaller Varea-meter, which costs less.

New W&T Varea-meters come in ⅜″ through 3″ sizes with 5″ and 10″ scales. They measure up to 310 gpm water or 1300 scfm air over a range of at least 10 to 1. Transmitters, magnetic indicators, and the usual accessories are available. Varea-meters conform to ISA Recommended Practice.

For more information, write Dept. V-5.48.

WALLACE & TIERNAN INC.

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

CIRCLE 22 ON READER-SERVICE CARD

ICS NEWS

Summer Metrology Course

WASHINGTON, D. C.—George Washington University's Center for Measurement Science offers a special summer course on the science of precise measurement, August 14 to 25. The Center, established last fall with the support of the National Bureau of Standards and The Martin Company, offers now a complete undergraduate and graduate schedule of study.

Weston to Recertify Cells

NEW YORK, N. Y.—Following an announcement that the U. S. Bureau of Standards has discontinued certification of unsaturated standard cells, Daystrom, Inc., Weston Instruments Division, (2530 Polk St., Union, N. J.) announces three services for recertification of these laboratory standards.

The classes of recertification are as follows: (1) Standard recertification of cell, (2) special recertification of cell, and (3) replacement with new cell and recertification. Weston recommends recertification of all unsaturated standard cells at least once every year for most accurate results.

CIRCLE 196 ON READER-SERVICE CARD

Fluid Controls Institute Meets

POMPANO BEACH, FLA.—The 1961 Annual Meeting of the Fluid Controls Institute, Inc., held at The Cloister, Sea Island, Georgia, May 21 to 23, 1961, was attended by the representatives of all prominent manufacturers of automatic regulator valves, control valves, solenoid valves, safety and relief valves, etc. The following Officers were elected to serve for the coming year:

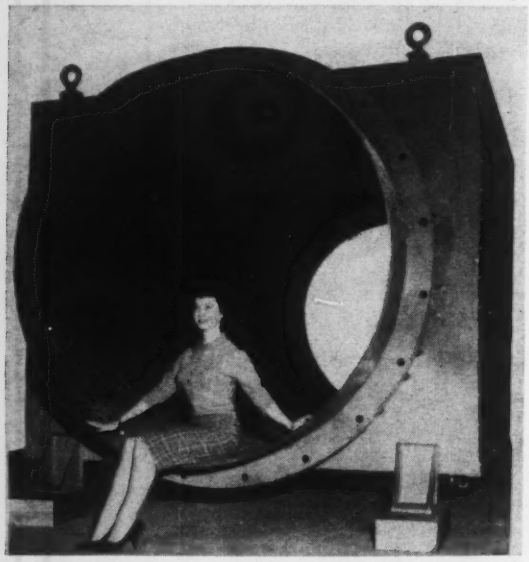
President: **Robert F. McCormick,** Automatic Switch Co.; First Vice President: **Eric A. Bianchi,** Mason-Neilan, Div. of Worthington Corp.; Second Vice President: **Samuel J. Reid,** Barnes & Jones, Inc.; Treasurer: **Paul K. Rogers, Jr.,** Skinner Electric Valve Div., Skinner Precision Industries, Inc.; Corporate Secretary: **Howard J. McDonald,** Minneapolis-Honeywell Regulator Co., Valve Div.; Executive Secretary: **E. R. Rath,** Fluid Controls Institute, Inc. The Fall Meeting of the Institute will be held at Hotel Hershey, Hershey, Pa., October 29-31, 1961.

ELECTRONIC ASSOCIATES INC. (EAI) held an intense two-week course on analog computer applications June 5 to 16. EAI Computation Center at Los Angeles, Inc., 1500 East Imperial Highway, El Segundo, Calif.

ROBERTSHAW-FULTON CONTROLS CO. (Aeronautical and Instrument Div., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.) has supplied four Vibraswitch malfunction detectors for a 2,000-h.p. electric motor-driven multi-state oxygen compressor installed at U. S. Steel's Clairton (Pa.) plant. A report (V 107) describes how early detection of barely perceptible malfunction vibrations prevented widespread damage to the costly unit.

CIRCLE 197 ON READER-SERVICE CARD

FISCHER & PORTER recently delivered the largest magnetic flowmeter ever manufactured, a seven-ton giant



with a 78″ diameter tube, to the Seadrift, Texas, plant of Union Carbide Chemicals Company. With a maximum flow capacity of 450,000 gpm, the meter will measure the quantity of water being pumped from the chemical plant's cooling water basins. (Fischer & Porter Co., Warminster, Pa.)

CIRCLE 198 ON READER-SERVICE CARD

LEEDS & NORTHRUP has furnished the complete instrumentation for the 60,000-kilowatt, $15-million nu-

clear test reactor at the Plum Brook Research Facility of the National Aeronautics and Space Administration near Sandusky, Ohio. The L & N equipment includes a thermal computer for measuring the reactor power output. (Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.)

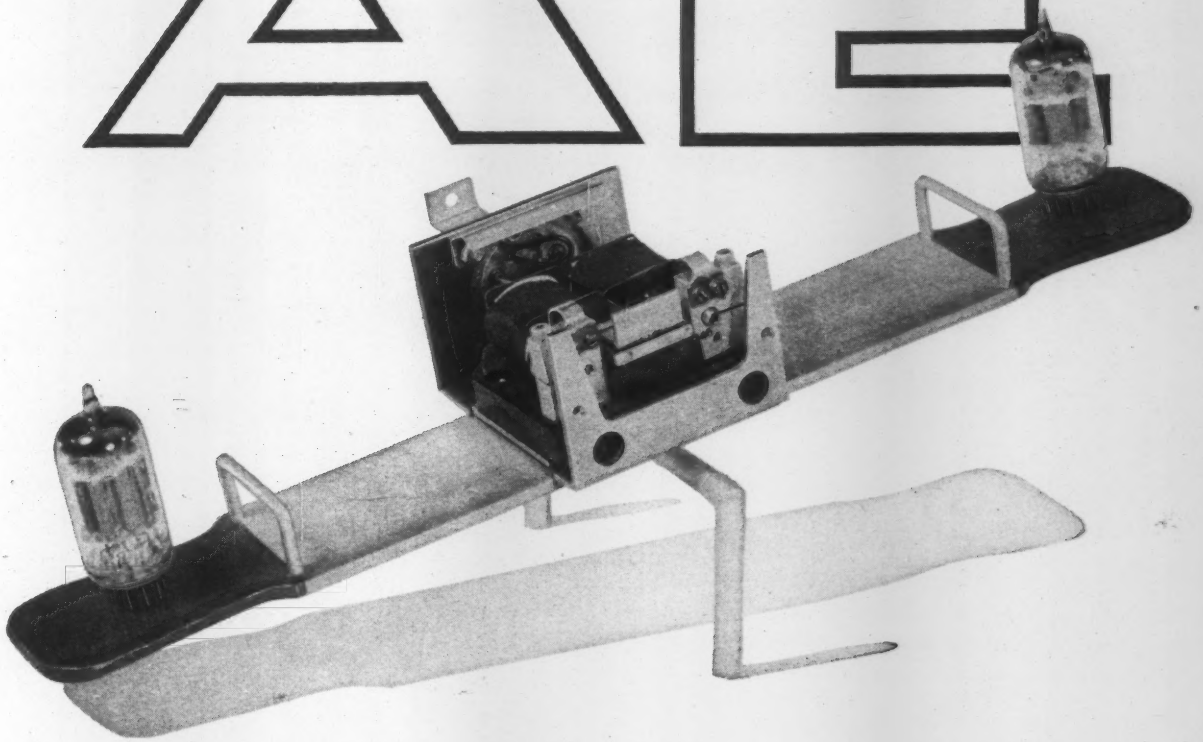
CIRCLE 199 ON READER-SERVICE CARD

The "Thomas A. Edison"

WEST ORANGE, N. J.—The nation's newest Polaris-type atomic submarine, christened June 15th, bears not only the name of Thomas A. Edison but its control system is protected by instruments developed and produced by the McGraw-Edison Company, corporate heir of the great inventor. Omniguard monitors, a product of McGraw-Edison Company's Instrument Division at West Orange guard critical temperature areas.

CIRCLE 200 ON READER-SERVICE CARD

AE



To the Engineer

looking for a fast circuit seesaw

If you're in need of something better than a flip-flop that only *partially* transfers a circuit —something with a transit time of less than a millisecond—then you'll be delighted with AE's Series PTW Polar Relay. This magnetically biased relay will transfer a circuit with the beautiful regularity of an observatory clock, and trigger on only a few mils from your available energy source.

Substantially smaller than other polar relays, the PTW's unique design virtually guarantees the high-speed switching of a single circuit *billions of times without readjustment!* Its service records to date in telegraph and teleprinter circuits and differential controls suggest that its life is practically limitless. Terminals to meet your specs.

Our circuit engineers will be happy to work with you in adapting the PTW to your designs. Or possibly you'd like to leave the switching to us—in which case we can take on the complete packaging and more than likely shave your costs.

For full information on the PTW, ask for Circular 1821-E – *and* for answers to your control problems, write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois.

AE CAN DO

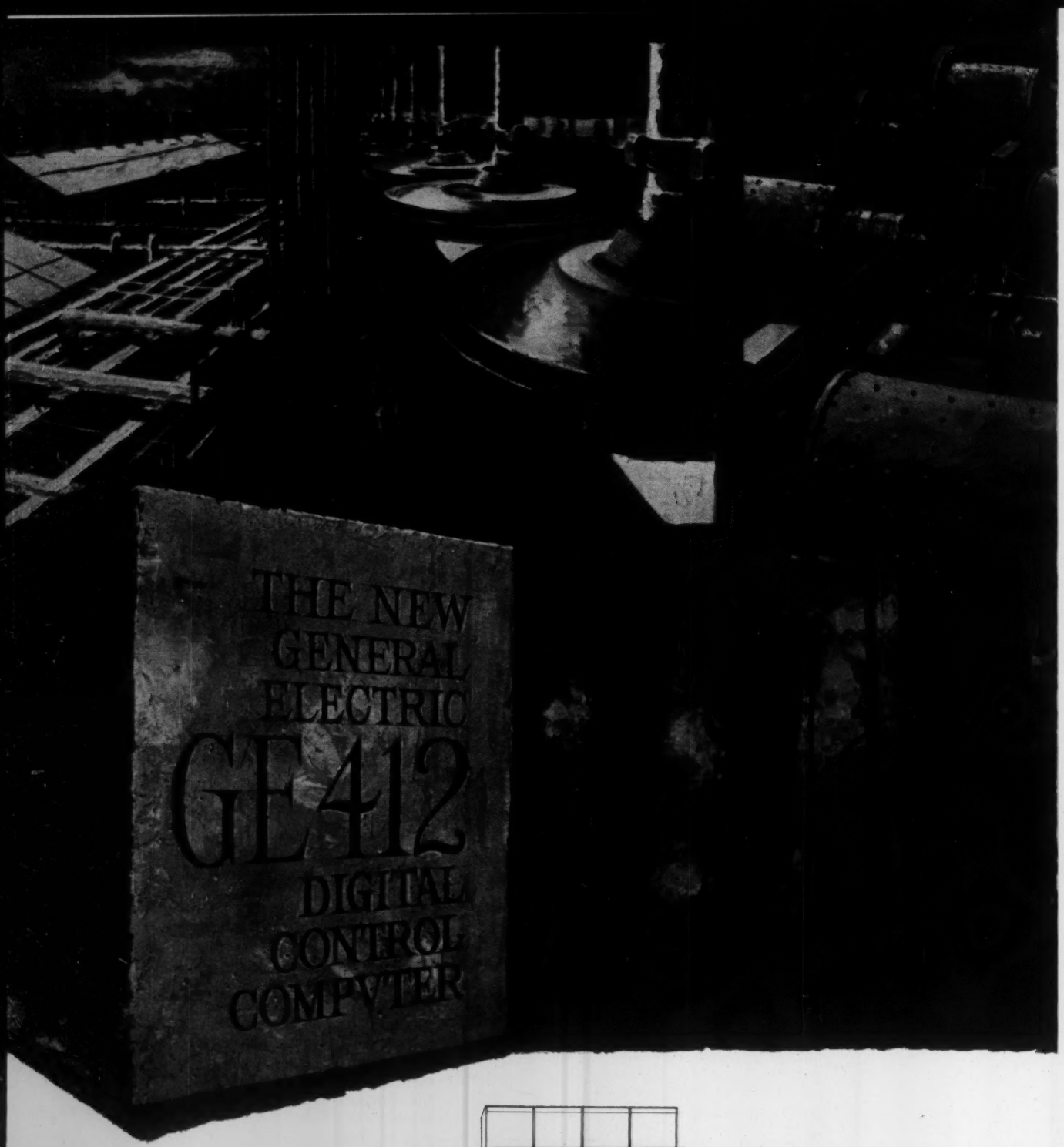
AUTOMATIC ELECTRIC

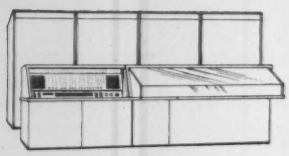
Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

GENERAL TELEPHONE SYSTEM

CIRCLE 23 ON READER-SERVICE CARD





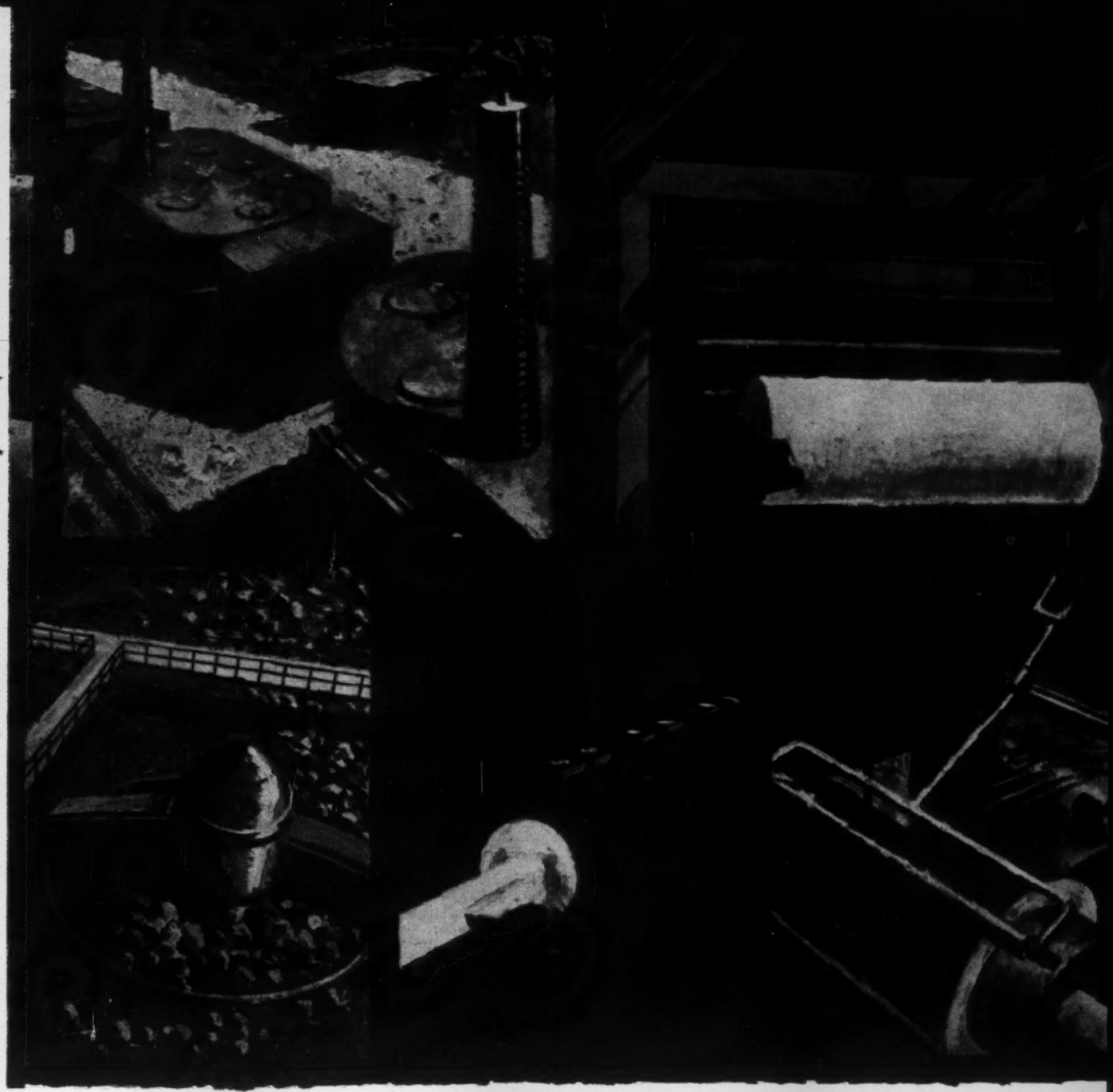
CORNERSTONE FOR YOUR AUTOMATION PROGRAM

CHEMICALS • ORE REDUCTION
PETROLEUM REFINING • PAPER • GLASS
CEMENT • ALUMINUM • UTILITIES • STEEL

General Electric announces the new GE 412, a second generation solid-state, stored program computer designed solely for industrial and utility applications.

The GE 412 Digital Control Computer, new "big brother" in the General Electric family of process computers, has been designed with the total systems concept and flexibility of equipment organization in mind.

PCA-2



The resultant versatility and capability of the GE 412 makes it custom-adaptable to many particular applications in many varied industries—data-logging and monitoring, data-logging and control, economic dispatching, director (or dispatcher) in a multi-control system.

The new GE 412 is extremely fast—capable of 25,000 additions a second. It incorporates a core memory with drum memory backup, plus more than 100 basic commands, to provide wide programming flexibility. The Automatic Program Interrupt feature and Programmable Elapsed Time Counters permit the regular survey of critical points without wasting valuable computer time required for constant checking.

General Electric offers you the two basic elements for your automation program—the new GE 412 Digital Control Computer and the application experience necessary to get it operating efficiently in your plant.

General Electric engineers can detail the available full line of input/output equipment and computer services including SYSTEM DESIGN, PROGRAMMING and AIDS, TRAINING, INSTALLATION SERVICES, and MAINTENANCE SERVICES—offered by General Electric to get your automation program in operation quickly... for lower production costs, increased profits.

INVESTIGATE THE NEW GE 412—*contact your nearest General Electric Apparatus Sales Office or the Process Computer Section, Industry Control Department, P.O. Box 2918, Phoenix, Arizona.*
IN CANADA, *contact Canadian General Electric Apparatus Sales Department, Peterborough, Ontario.*
OUTSIDE THE U.S. AND CANADA, *contact International General Electric, 150 East 42nd Street, New York 17, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

CIRCLE 24 ON READER-SERVICE CARD

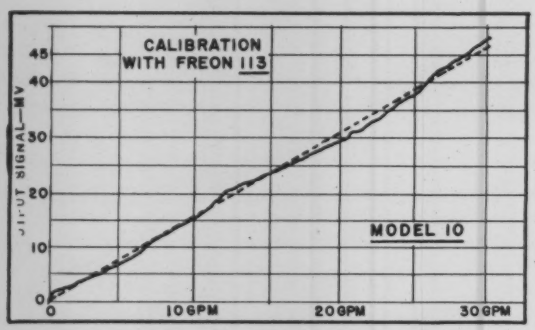
New Flow Transducer

WIDE RANGE LINEAR STRAIN GAGE OUTPUT

Standard Controls' Flow Transducer Accurate to 2% from 0 Flow to Full Scale. Available in Ranges of 0-0.5 gpm through 0-200 gpm.

Based on the cantilever reed principle, Standard Controls' new flow transducer produces a linear output with less than 2% full scale deviation, from 0 to full rated flow. Dynamic response is faster than 90% of step function input in less than 10 milliseconds.

NO MOVING PARTS. Mechanically simple, the new transducer has no rotating parts, no bearings, no hinge action. All movements are cantilever bending.



Actual linearity curve for Standard Controls new flow transducers. (0 to 30 gpm ranges.)

BONDED STRAIN GAGE DESIGN. Electrically, the design consists of a 4-active-arm, bonded strain gage bridge which senses flow against a cantilever reed in the flow stream. Sensitivity is 4 mv/volt. Flow is uni-directional. Repeatability errors are less than 0.25% of full scale. Environmental range is −65°F to +300°F.

DIMENSIONS AND OPTIONS. A typical unit weighs 8 ounces and occupies a volume of 1¼"D x 1"W x 4"H. For telemetry purposes, a signal conditioning amplifier is incorporated to provide a 5 volt full scale output. Electrical and mechanical configurations can be modified for specific applications.

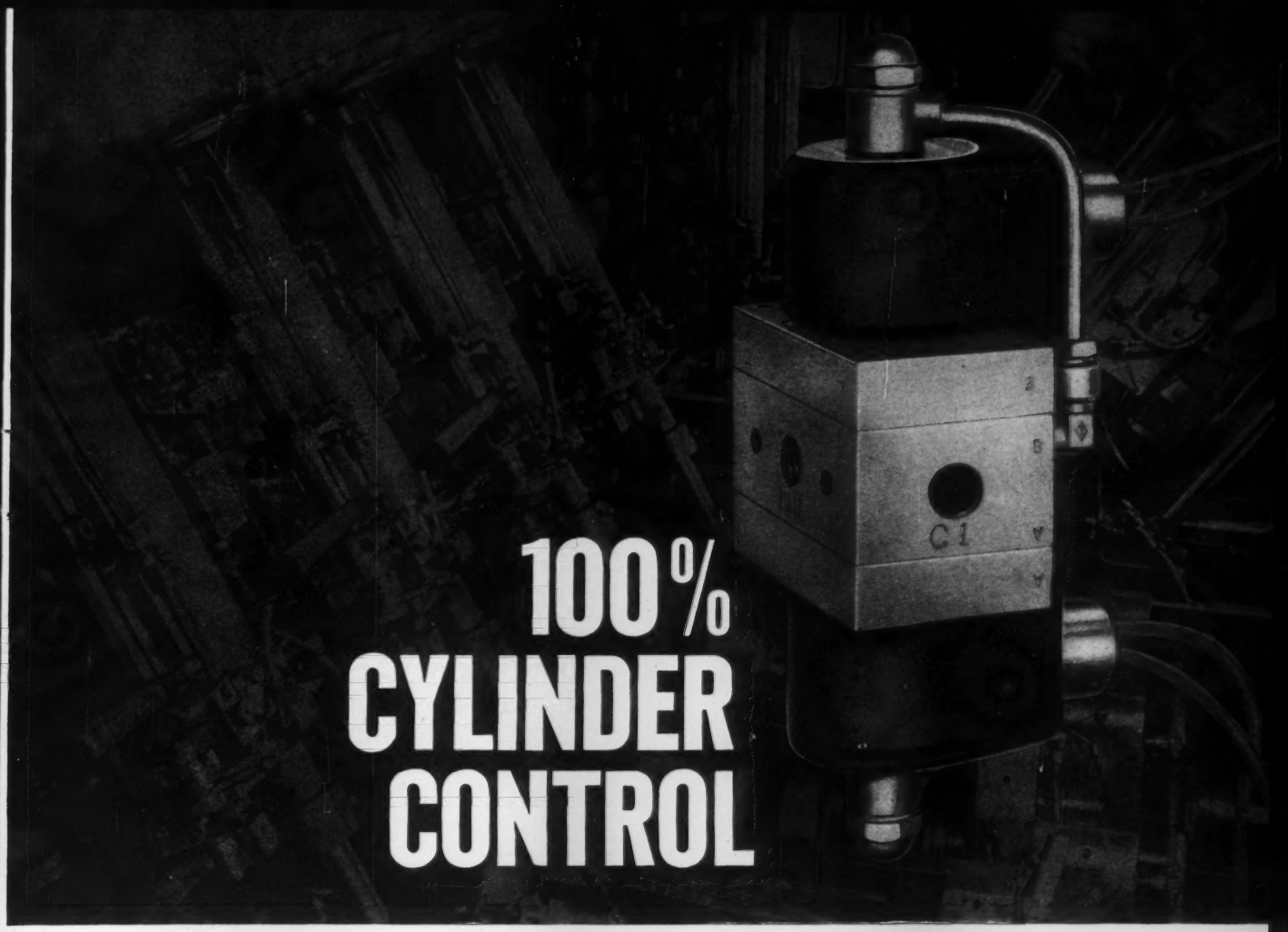
NEED MORE INFORMATION? Call your nearby Standard Controls engineering representative whose name and phone number is listed below, or write to:

Standard Controls INC.

STANDARD CONTROLS
1130 Poplar Place So. • Seattle, Washington
Phone: EAst 4-8888

STANDARD CONTROLS' REPRESENTATIVES: CEDAR RAPIDS, Iowa, Engineering Services Co., Phone: EMpire 5-6183 • CIRCLE PINES, Minnesota, Pat Lind Electronics Co., Phone: SUnset 4-3827 • DALLAS, Texas, Ammon and Champion Company, Phone: FLeetwood 7-3939 • ENGLEWOOD, Colorado, Thorson Company, Phone: SU 9-1841 • HERMOSA BEACH, California, Systems Instrument Sales Co., Phone: FRontier 9-8251 • IDAHO FALLS, Idaho, Seatronics, Inc., Phone: JAckson 2-7992 • KANSAS CITY, Missouri, Engineering Services Co., Phone: PL 3-7227 • PALO ALTO, California, Egbert Engineering of California, Phone: DA 6-1387 • SEATTLE, Washington, Seatronics, Inc., Phone: EAst 3-8545 • ST. LOUIS, Missouri, Engineering Services Co., Phone: PArkview 6-2233 • WELLESLEY HILLS, Massachusetts, John J. Goode Associates, Phone: CEdar 5-0552 • WICHITA, Kansas, Engineering Services Co., Phone: MUrray 5-3751

CIRCLE 25 ON READER-SERVICE CARD



100% CYLINDER CONTROL

DEAD-TIGHT SEATING OF ASCO 4-WAY SOLENOID VALVE PREVENTS PISTON DRIFT ...PERMITS PRECISION INCHING

- *3-POSITION, 4-WAY DESIGN*
- *POPPET-TYPE SEATING— CANNOT STICK OR LEAK*
- *INSTANTANEOUS OPERATION*
- *EXPLOSION-PROOF ENCLOSURE AVAILABLE*
- *PRESSURES UP TO 250 PSI ON AIR, WATER OR OIL*
- *RUGGED BRASS BAR STOCK*
- *2 SOLENOID CORES AND 4 DIAPHRAGMS ARE ONLY MOVING PARTS*

Positive control of the cylinder piston is inherent in the design of this ASCO Bulletin 8347 valve. Leakage of air or liquid is made impossible, so that whenever both solenoids are de-energized, the valve assumes a center position and all orifices are blocked, locking cylinder piston in position. Dead-tight (poppet-type) valve seating permits precision inching of the piston, as well as absolute control of any length of stroke, with instantaneous stopping and not a trace of drift.

The utter simplicity of design and rugged construction assure many millions of trouble-free operations. You can choose the 8347 in either the ¼" or the ⅜" pipe size for pressures to 250 psi, and you can mount it in any position. It is available from stock for immediate delivery, as are other ASCO solenoid valves.

Write for Bulletin 8347, providing complete descriptive information on this new, reliable 4-way.

ASCO Valves ASCO

DEPENDABLE CONTROL BY Automatic Switch Co. 52F HANOVER RD., FLORHAM PARK, N. J. • FRONTIER 7-4800 • *AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL*

CIRCLE 26 ON READER-SERVICE CARD

CARL ZEISS

Made in West Germany

Symbol of High Quality

SINCE 1846

A few of the many outstanding instruments which embody the traditions of this famous trade-mark:

UNIVERSAL MEASURING MICROSCOPE
LARGE & SMALL TOOLMAKER'S MICROSCOPES
GAGE BLOCK INTERFEROMETER
VERTICAL & HORIZONTAL METROSCOPES
LARGE & SMALL OPTICAL DIVIDING HEADS
CAM SHAFT TESTER
CIRCULAR DIVISION TESTER
OPTICAL ROTARY TABLE
OPTICAL PROTRACTOR LEVEL
OPTICAL FLATS
INTERFERENCE MICROSCOPE
INTERFERENCE SURFACE TESTER
LIGHT SECTION MICROSCOPE
METALLURGICAL MICROSCOPE
STEREO MICROSCOPE
EPI TECHNOSCOPE
ULTRAPHOT II for incident illumination with automatic exposure-setting device
PHOTO MICROSCOPE for incident illumination with automatic exposure-setting device

Write for free, detailed specifications on equipment of interest to you.

CARL ZEISS, INC.

485 FIFTH AVENUE, NEW YORK 17, N.Y.

COMPLETE SERVICE FACILITIES

Oberkochen, West Germany

CIRCLE 27 ON READER-SERVICE CARD

IGS STOCK REPORT

Further information may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

NEW YORK STOCK EXCHANGE
PRICE RANGE FOR 1961 THRU June 16, 1961

	High	Low	Price As Of 6/16/61
ACF Industries	60	38	56 1/2
Aeroquip Corp.	36 5/8	22 1/4	29 1/8
Allis Chalmers	29 1/2	23 3/8	26 1/4
American Chain & Cable	53	42 7/8	48 3/4
Amer. Mach. & Foundry (new)	63 5/8	47 1/4	47 7/8
Amer. Mach. & Metals	48	34 1/8	44 1/8
American Meter	53 3/4	43	49 1/2
American Optical	78 3/8	54	74
American Tel. & Tel.	130	103 1/8	116 1/4
Ampex Corp.	27 3/4	20 1/4	21 1/4
Aro Equipment	35 1/2	20 1/8	29
Bausch & Lomb Optical	46 5/8	38 1/4	44
Beckman Instruments	125 3/4	87	116 1/2
Bell & Howell	69 7/8	48 3/4	61 1/4
Bendix Aviation	72	59 1/4	59 1/2
Boeing Airplane	48 1/4	35 1/2	45 7/8
Bullard	19 3/8	11 1/4	15 1/2
Bulova Watch	22 1/4	15 7/8	17 7/8
Burroughs	38 1/4	27 1/2	30 3/8
Carborundum	60 1/4	44 1/4	58
Cinn. Milling Machine	49 1/4	37 1/2	41 1/2
Clevite	70 5/8	47 3/4	68 1/2
Columbia Broadcasting Sys.	42 3/8	35 3/8	37 1/4
Consol. Electronics	46 1/2	36 1/8	42 1/2
Corning Glass	194 3/4	167	177
Curtiss Wright	22	15 5/8	17 1/8
Cutler-Hammer	78	62 3/8	75
Daystrom	34 3/4	25 1/4	25 5/8
Douglas Aircraft	38 1/2	28	32
Eastman Kodak	119 3/4	104 1/4	106 1/2
Eaton Mfg.	38	30 3/8	36
Electric Auto-Lite	67 3/4	44 5/8	59 1/4
Elgin Watch	16 7/8	11 3/4	13 7/8
Emerson Electric	87 1/2	50	70 1/2
Engelhard Industries	33 7/8	18 1/2	26
Food Mach. & Chem.	76 1/2	59 1/8	73 1/4
Foxboro Co.	87	67	72
Garrett	56 3/8	46 3/8	48 3/8
General Controls	22 1/2	16 1/2	17 1/4
General Dynamics	45 1/2	34 1/2	34 1/4
General Electric	74	60 1/2	63 7/8
General Instruments	55 1/2	37 5/8	42 5/8
General Mills	37	31	33 1/8
Gen. Precision Equip.	78	54 1/2	68 1/2
Gen. Railway Signal	54 3/4	29	48 1/2
Gen. Tel. & Elect.	32 1/2	26 3/8	26 1/8
General Time	30 3/8	24 1/4	24 5/8
General Tire & Rubber	79 3/8	53 3/4	74 7/8
Hewlett-Packard	53	35 1/8	36 5/8
International Bus. Mach.	499	447	481 1/2
International Resistance	42 1/8	26	33 1/2
Interhat'l Tel. & Tel.	60 7/8	44 3/4	55 1/4
I-T-E Circuit Breaker	24 5/8	18	20 1/2
Lear Inc.	29 3/8	16	23 7/8
Litton Industries	143	87 1/8	121 3/4
Lockheed Aircraft	45 5/8	26 1/2	44 1/4
Magnavox	96 3/4	46	84 1/4
Mallory	60 3/8	36 5/8	56 1/8
Manning, Maxwell & Moore	30 3/8	21 7/8	28 1/4
Minneapolis-Honeywell	170 3/4	140	154
Minnesota Mining & Mfg.	87 5/8	70 1/8	83 1/2
Motorola	100	75 1/8	89
National Acme	59 1/2	47	55 3/4
National Cash Register	104 1/2	61 7/8	95 1/2
Neptune Meter	29 1/2	22 7/8	26 3/8
North American Aviation	53 5/8	41 5/8	46 1/2
Northrop Aircraft	67 3/8	41 1/2	57 1/2
Otis Elevator	79	56 1/2	71 3/4
Philco Corp.	25 5/8	17 3/4	23 1/4
Radio Corp. of Amer.	65 5/8	49 1/2	57 5/8
Raytheon Mfg.	43 1/2	35 1/4	38 7/8
Reliance Electric	67	47 1/2	58 1/4
Rheem Mfg.	23 1/2	13 1/2	18 3/4
Robertshaw Fulton	47 3/4	32 7/8	44
Royal McBee	19 3/8	13 1/4	14 1/2
Sangamo Electric	22	14 3/8	17 1/4
Siegler Corp.	34	27	28 1/8
Sperry Rand	35	20 1/2	27 3/4
Square D	42 3/4	29 5/8	39 3/4
Standard Kollsman	53 1/4	25 1/8	47 3/8
Starrett (L.S.)	22	17 3/4	20 1/4
Stewart-Warner	32 1/4	24 3/4	30 1/8
Telautograph	20 7/8	12 5/8	15 1/8
Texas Instruments	206 3/4	165 3/4	171 3/4
Thompson-Ramo-Wooldridge	82 3/8	59 5/8	63 3/4
Tung-Sol Electric	33 3/8	25 3/8	29 3/4
Underwood Corp.	65 1/2	42 1/2	59 3/4
Union Carbide Corp.	144	116	140
United Shoe Machinery	76 1/4	54 5/8	72 1/4
Varian Associates	77 3/8	46 5/8	57 1/2
Wallace & Tiernan	46 1/2	26 1/2	37
Western Union	55	39 3/4	42 3/4
Westinghouse Air Brake	28 3/4	22	26 1/2
Westinghouse Electric	50	40	44
Worthington Corp.	67 1/4	49	60

These prices and price ranges are given as printed in the Wall Street Journal.

AMERICAN STOCK EXCHANGE
PRICE RANGE 1961 THRU June 16, 1961

	High	Low	Price As Of 6/16/61
Barry Wright	29 3/4	15	22 1/2
Belock Instruments	20 1/4	14 5/8	16 1/4

Benrus Watch	11 1/2	6	9 7/8
Breese Corp.	9 5/8	4 1/8	8 1/2
Burnell & Co.	17 3/8	6 1/2	14
Clark Controller	21 1/4	16 1/2	18 1/4
Clarostat Mfg.	20	12	15 3/8
Clary Corp.	22 3/8	8 5/8	15 1/8
Cubic Corp.	106	51 1/2	85
Dynamics Corp. of Amer.	20 1/4	7 5/8	14 5/8
El-Tronics	9 3/4	5	6 1/2
Electronics Corp. of Amer.	14 1/2	9	11 5/8
Fairchild Camera & Instruments	195 1/2	130	162
Fischer & Porter Co.	31 7/8	16	29
Giannini Controls	82 1/4	52	62 3/4
Globe Union	35 1/2	23 1/2	(a)33 1/4-33 7/8
Hasaltine Corp.	47 7/8	28 1/2	36 3/4
Loral-Electronics	46 1/4	31 5/8	36 3/8
National Research	31 7/8	17 5/8	23 1/4
New Haven Clock	2 1/2	1 1/8	2 1/8
Nuclear Corp. of Amer.	8 1/4	3 7/8	6 1/2
Philips Electronics, Inc.	39 1/2	31 1/4	38
Pneumatic Scale	50	39	(a)44-45 3/4
Pola-rad Electronics	28 3/8	18 3/4	22 3/8
Servo Corp. of Amer.	19	11 1/4	13 1/8
Servomechanisms	13 1/4	7 3/4	10 1/4
Statham Instruments Inc.	35 3/8	24 1/8	24 3/8
Textron Electronics	14 3/8	9 1/8	9
Victoreen Instrument Co.	19 1/4	13 1/8	15
Waltham Prec. Instr. Co.	4 7/8	1 3/4	4 1/8

These prices and price ranges are given as printed in the Wall Street Journal.

(a) Not traded

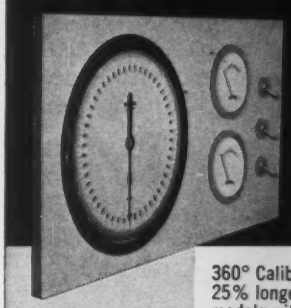
OVER THE COUNTER

Quotation As Of June 16, 1961

	Bid	Asked
Aerovox Corp.	11 1/2	12 1/4
Argus Corp.	38 1/4	39
Black Sivalls & Bryson Inc.	13 1/4	14
Computer Systems	25	27
Kitel McCullough	14 3/4	15 1/4
Electro Instruments	21 1/2	23
Electronics Associates	33	34
Erie Resistor Corporation	13 5/8	14 3/8
Fisher Governor Co.	23 1/2	24
Hagan Chemicals & Controls	54	58 1/2
Milgo Electronic Corp.	21	22 5/8
Industro Transistor	4 5/8	5 1/4
Liquidometer Corp.	14	15
Maxson Electronics (b)	23 1/2	24 1/4
Penn Controls	25	25 1/2
Speer Carbon, Inc.	30 1/2	31 1/4
Sprague Electric	77	78 1/4
Taylor Instruments	51	52 1/2
Telechrome Mfg. Corp.	11	11 3/4
Telecomputing Corp.	7	7 1/2
Vitro Corp. of Amer.	23 1/2	24
Wallson Associates Inc.	5	5 3/4

(b) Name changed from W. L. Maxson

NEW *Martin-Decker* **Precision Test Gauge** *makes pressure readings* **25% More Accurate**



8½" Dia. Dial — 25.13" Scale Length

12" Dia. Dial — 36.91" Scale Length

- **Big scale readings in small scale space!**
- **Greater Accuracy!**
- **Requires less panel space!**

360° Calibration makes Martin-Decker Scale 25% longer—gives 25% greater readability than models with 270° scale.

Ni-Span C Bourdon tube is temperature-stable, corrosion-resistant—superior to other alloys.

Tube tip bleed is standard equipment.

Movement calibrated to dial, with an accuracy of ± 0.15% or better.

Uniform linear increments. Protected front zero adjust.

Capacities from 60 PSI to 15,000 PSI.

Find out why more and more O.E.M. designers specify Martin-Decker Precision Test Gauges for measuring gas and fluid pressures.

MARTIN DECKER

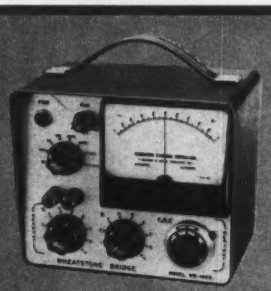
Write for Technical Brochure T57

Precision Pressure Instruments Testing—Weighing—Load and Force Measurement

MARTIN DECKER PRECISION TEST GAUGES

MARTIN-DECKER CORPORATION • 3431 Cherry Ave., Long Beach 7, Calif.

CIRCLE 28 ON READER-SERVICE CARD



MODEL WB-100A WHEATSTONE BRIDGE

Accuracy . . .03% + .005 ohms absolute.

Range . . . . . 1 ohm to 100 megohms.

Sensitivity . . . . . 1 mv. full scale.

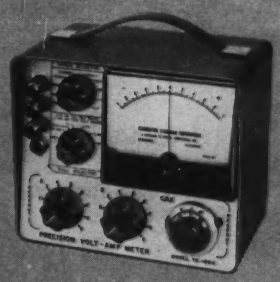
Price: $495. *

MODEL VA-100A VOLT-AMP METER

Voltage Accuracy . .05% +5 uv absolute.

Current Accuracy . . . . . 0.1% +.001 ua.

Range . . . . . 0-1000 Volts, 0-1000 MA.



Price: $625. *

CALIBRATION > STANDARDS Precision Wheatstone Bridge and Volt-Amp Meter

CSC's Model WB-100A Wheatstone Bridge with integral Galvanometer and Power Supply is a single, compact unit. High resolution with a sensitive amplifier, 5 digit readout over entire range. Completely transistorized and portable, this accurate bridge is an ideal resistance comparator for Receiving Inspection and Production Calibration. Operates on 115 VAC. Uses chopper-stabilized amplifier for long term reliable measurements. Model VA-100A precision Volt-Amp Meter is self-calibrating. Incorporates ultra-stable Zener Reference package. Simple operation. Stability of ±.005% from 105 to 125 Volts insures precise laboratory measurements in a 5 digit readout. *Write for detailed specifications or contact your local CSC representative.*

LOS ANGELES, SMITH-DIETRICH SALES COMPANY • SEATTLE-PALO ALTO, STANLEY ENTERPRISES • DENVER-SALT LAKE CITY, EMF ASSOCIATES • CHICAGO, LOREN P. GREEN & ASSOCIATES • WICHITA, LAWRENCE L. HILL • WALTHAM, MASSACHUSETTS, GEO. GOSTENHOFER & ASSOCIATES • SCHENECTADY, CHARLES A. WINICK COMPANY • NEW YORK CITY (MT. VERNON), QED ELECTRONIC SALES, INCORPORATED • PHILADELPHIA (LANSDOWNE), HOLDSWORTH & COMPANY • ARLINGTON, VIRGINIA, THE JAY COMPANY • ATLANTA-COCOA BEACH, SPECIALIZED EQUIPMENT COMPANY • CLEVELAND-DAYTON-DETROIT, ELECTRO SALES ASSOCIATES • EXPORT, FRAZAR & HANSEN, LTD.

CALIBRATION > STANDARDS CORPORATION

a subsidiary of ROYAL > INDUSTRIES INC.

1025 Westminster Ave., Alhambra, Calif.

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CIRCLE 29 ON READER-SERVICE CARD

ICS TRENDS

For the first three months of 1961, 40,583,632 transistors worth $78,470,083 were sold at the factory, compared with 31,155,798 units worth $78,246,279 sold during the same period in 1960, says EIA.

American Standards Association Sectional Committee C92 has endorsed 345,500 and 700 kilovolts as the proposed American Standard Voltages for high-voltage AC System. More than 2600 miles of 330/345 kv transmission lines are in service.

Professional and technical workers are now 7½% of working force, compared to 4½% in 1900.

Electronics volume in terms of GNP is 1.9% in USA, 1.9% in Britain, 1.5% in Germany, under 1% in France, Says D. Rese of Ultra Electronics, Ltd., in British Communications & Electronics. French electronics volume in 1958 was $448 million, $504 million in 1959.

Market for nuclear measuring instruments (radiation detection or measurement) was $46 million in 1959, says the Business and Defense Services Administration, U. S. Department of Commerce. About 160 concerns manufacture the instruments, as follows:

	QUANTITY	VALUE
NUCLEAR MONITORING INSTRUMENTS: AREA AND PERSONNEL:		
Portable Survey Meters, 50 MR/hr Maximum Range	20,607	3,941
Portable Survey Meters, 10 R/hr thru 500 R/hr Maximum Range	20,741	2,493
Fixed Monitoring Instruments	2,171	955
Hand and Foot Counters*	xxx	xxx
NUCLEAR MONITORING INSTRUMENTS: ENVIRONMENTAL		
Air Particulate, Fixed and Moving Filter	169	989
Gas and Liquid	1,719	3,533
DOSIMETERS AND ACCESSORIES		
Self-reading Dosimeters	91,072	967
Other Dosimeters	14,549	438
Dosimeter Chargers and Charger Readers**	xxx	498
SCALERS		
Decade Scalers	3,553	2,643
Binary Scalers	744	235
AMPLIFIERS		
Preamplifiers	846	479
Linear Pulse Amplifiers	341	196
Pulse Amplifiers with Discriminators	625	358
Pulse Amplifiers, not specified by kind	1,340	751
DC Linear Amplifiers	959	585
DC Logarithmic Amplifiers	275	221
Special Function Amplifiers for Reactor Control	1,036	630

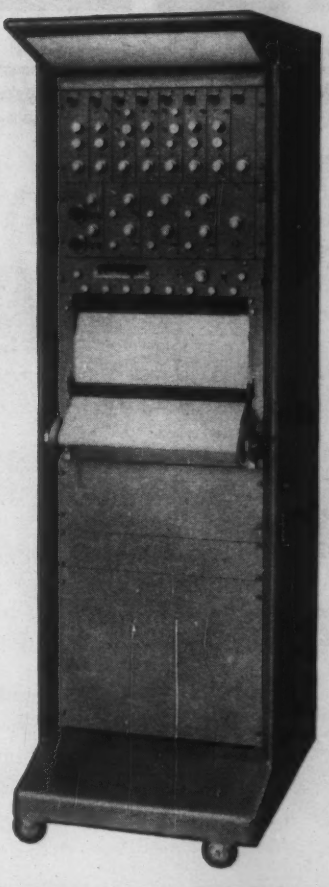
	QUANTITY	VALUE
PULSE HEIGHT ANALYZERS		
Single Channel	808	839
Multi-channel	860	2,685
NUCLEAR INDUSTRIAL INSTRUMENTS		
Gaging and Process Control	1,286	6,567
Radiography**	xxx	257
COUNT RATE METERS		
Linear	5,261	1,385
Logarithmic	224	181
Differential and Ratio*	xxx	xxx
MISCELLANEOUS NUCLEAR INSTRUMENTS AND ACCESSORIES		
Sample Changers, Manual and Automatic	1,116	914
Power Supplies, Fixed Voltage	16,071	3,533
Power Supplies, Variable Voltage	16,123	2,727
Detecting Heads Sold Separately		
Scintillation	2,126	1,087
Proportional	3,301	687
Geiger	113,073	1,610
Ionization Chamber	1,962	1,200
Solid State*	xxx	xxx
Chemical Detection Devices and Dosimeter Film**	xxx	1,955
Miscellaneous (includes items listed above for which data were withheld to avoid disclosure)	xxx	259
Radiation Sources***	13,869	1,638

* Data withheld to avoid disclosing figures for individual firms.

** Quantities are not additive because of dissimilarity in unit of measure.

***Quantity figure shows number of individual sources. There were consumed 316,248 curies of radioisotopes in producing this number of sources.

See it at
WESCON SHOW
Booths 1513-1514



TYPE

THE OFFNER R DYNOGRAPH

The most versatile and sensitive direct-writing unit available!

Ink, heat, electric recording media!

Handles all your recording requirements.

SILVER ANNIVERSARY
1936 1961
25 YEARS
OFFNER DIRECT-WRITING OSCILLOGRAPHS

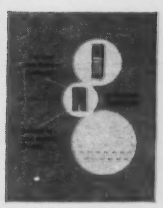
25 years ago Offner invented the world's first Direct-Writing Oscillograph.

This *one* high-speed direct writing assembly handles *all* your recording requirements. You change only the input coupler for thermocouples, strain gages, servo monitors; for industrial, scientific, and medical applications.

☆ From one microvolt, d-c to over 200 cps.

☆ Ink, heat, electric recording media—easily convertible.

Write for complete details.



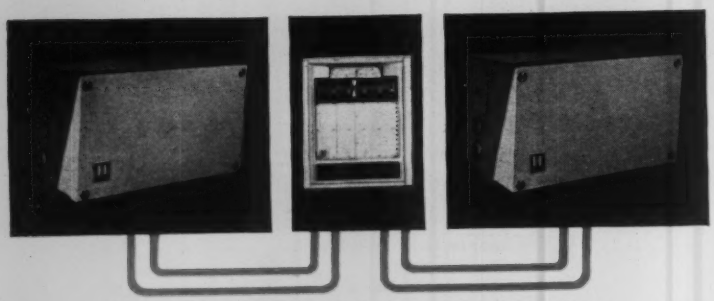
16 pages of facts, figures, and specifications on the Offner Type R Dynograph.

Write for your copy.

OFFNER ELECTRONICS INC.

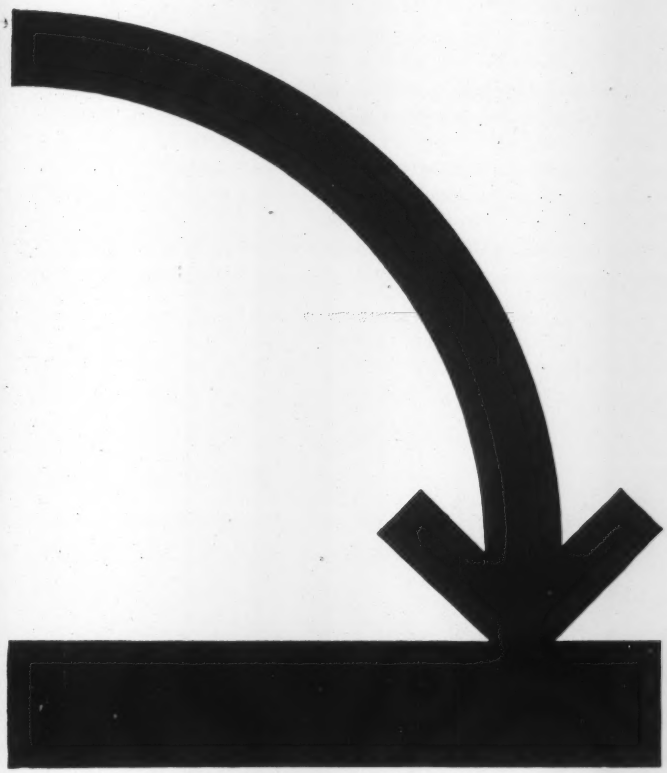
3910 River Road, Schiller Park, Ill.
(Suburb of Chicago)

CIRCLE 30 ON READER-SERVICE CARD



***ElectriK Tel-O-Set*—the true 2-wire system**

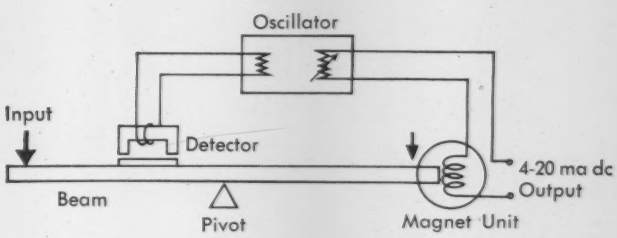
Care and feedback of delicate inputs



Delicate inputs thrive on the tender care of *ElectriK Tel-O-Set's force-balance feedback system*. This system, used as the basic circuit in *Tel-O-Set* transmitters, receivers, controllers, and other instruments, has proved itself in thousands of installations in the last five years. The force-balance feedback circuit increases the accuracy and dynamic response of the system by decreasing hysteresis effects and sensitivity to changes in ambient conditions.

Observe: (1) input force (from bellows, Bourdon tube, or displacement linkage) deflects pivoted beam; (2) air-gap in ferrite detector increases, (3) producing a change in inductance in oscillator circuit; (4) a portion of output current is fed back into magnet unit, producing a force on beam which is equal and opposite to input force; feedback balances beam. Full scale motion is only one-thousandth of an inch.

The advanced control engineering seen in force-balance feedback is carried through the entire *ElectriK Tel-O-Set* System. Specifically, there's no external power required at any field-mounted *Tel-O-Set* instrument. Line power connection is made only at the receiver. Two-wire d-c transmission eliminates shielding problems. The 4-20 milliamp signal range of the system gives a live zero and permits the use of the most reliable transistors available. The d-c signals



can be fed into data handling systems and millivolt-actuated instruments . . . can be easily transduced to a standard 3-15 psi pneumatic signal to operate existing pneumatic systems.

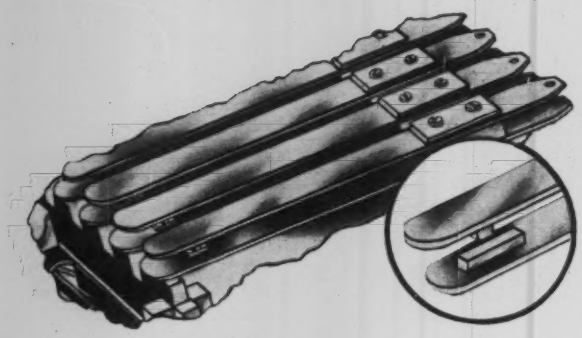
Take a new look at your control applications with the *ElectriK Tel-O-Set* System in mind! Get complete technical data from your local Honeywell field engineer. Call him today . . . he's as near as your phone. MINNEAPOLIS-HONEYWELL, 21 Penn Street, Fall River, Massachusetts.

Honeywell

First in Control

SINCE 1885

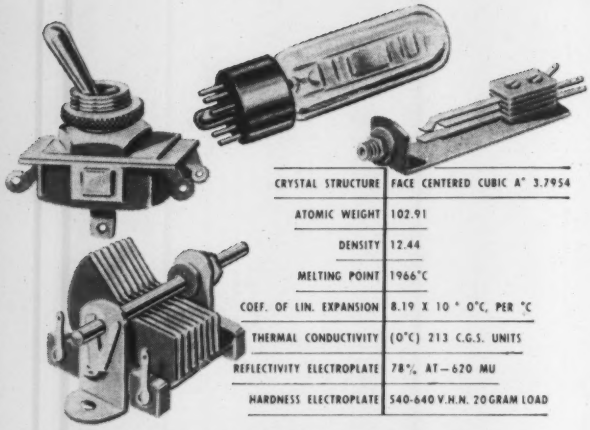
CIRCLE 31 ON READER-SERVICE CARD



ECONOTAPE CONTACTS ARE MOST EFFICIENT FOR ELECTRICAL RELAYS

High reliability welded contacts and contact assemblies available for your relays. Weld strength guaranteed. • Overall contact height held within ±.00025. Assemblies are available in gold, platinum, palladium, silver and their various alloys—both solid and laminated. Single contact usable for various contact ratings, for wet and dry circuitry—assemblies protected for shelf life and handling. Designs for attachment to header by welding or brazing. Complete electrical and mechanical design services available.

D. E. MAKEPEACE DIVISION
PINE & DUNHAM STREET • ATTLEBORO, MASS.

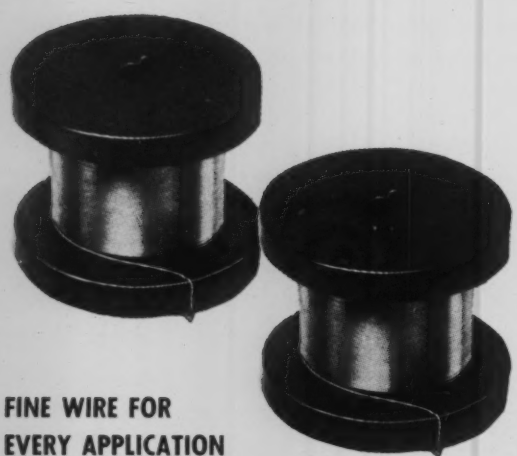


CRYSTAL STRUCTURE	FACE CENTERED CUBIC A° 3.7954
ATOMIC WEIGHT	102.91
DENSITY	12.44
MELTING POINT	1966°C
COEF. OF LIN. EXPANSION	8.19 X 10 ° 0°C, PER °C
THERMAL CONDUCTIVITY	(0°C) 213 C.G.S. UNITS
REFLECTIVITY ELECTROPLATE	78%, AT—620 MU
HARDNESS ELECTROPLATE	540-640 V.H.N. 20 GRAM LOAD

RHODIUM PLATING RESISTS CORROSION

Rhodium plating offers outstanding protection against surface corrosion under all atmospheric conditions. Used in electrical and electronic applications, it improves efficiency whenever a low-resistance, long-wearing, oxide-free component is required . . . assures low noise level for moving components . . . provides positive action for components subject to long periods of inactivity . . . eliminates partial rectification and unwanted signals by keeping components oxide-free. Send for complete technical data.

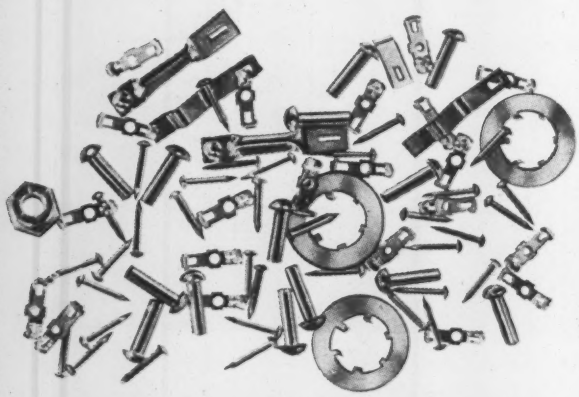
CHEMICAL DIVISION
113 ASTOR STREET • NEWARK, N. J.



FINE WIRE FOR EVERY APPLICATION

A thoroughly dependable source for fine wire of ductile and non-ductile materials for every application. Special processes have been developed for bare drawing wire as fine as .0004". Wollaston Process for ductile metals . . . Taylor and extrusion methods for non- ductile metals are employed to meet requirements for finer wire. All standard fine wires are stocked for prompt delivery. Full facilities are available for production of fine wire made to customer's individual requirements. Write for details.

BAKER PLATINUM DIVISION
113 ASTOR STREET • NEWARK, N. J.
FOR ECONOTAPE CIRCLE 32 ON READER-SERVICE CARD
FOR FINE WIRE CIRCLE 33 ON READER-SERVICE CARD



SIMPLIFIED SILVER PLATING FOR ELECTRICAL AND ELECTRONIC COMPONENTS

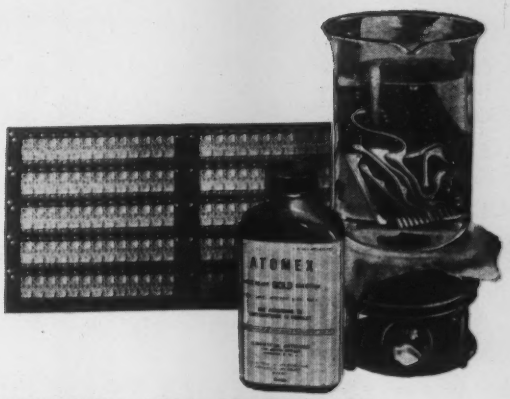
The simplest, most efficient process for protecting electrical, electronic and lamp components with mirror-bright silver plating in flash to heavy deposits. Silva-Brite is a crystal-clear solution—work is visible during plating process. Plating is quick, easy, non-critical with results assured at current densities from 10 to 40 amps psf—and little or no polishing required. Normal room temperature operation minimizes fumes and bath decomposition. Write for complete information on Silva-Brite and application procedure.

AMERICAN PLATINUM & SILVER DIVISION
231 N. J. RAILROAD AVENUE • NEWARK, N. J.
FOR RHODIUM PLATING CIRCLE 34 ON READER-SERVICE CARD
FOR SILVER PLATING CIRCLE 35 ON READER-SERVICE CARD

PLATINUM SPIRALS MEASURE TEMPERATURE BY ELECTRICAL RESISTANCE CHANGE

Precise electrical thermometer using platinum spirals provides temperature measurements within ± 1/10th of 1°C. Voltage signal varies with temperature for covering a range from −220°C to +500°C. The temperature transistor elements, sealed in hard glass thin wall tubes, provide fast time response. 25, 50 or 100 ohm units available as well as a selection of tube geometries. A similar group of platinum spirals are ceramic encased for measuring temperatures as high as 750°C with slightly less accuracy. Special laboratory standard precision electrical thermometers also available.

INDUSTRIAL EQUIPMENT DIVISION
INSTRUMENTS AND SYSTEMS SECTION
850 PASSAIC AVENUE • E. NEWARK, N. J.



IMMERSION GOLD COATING FOR ELECTRICAL AND ELECTRONIC PARTS

Use Atomex gold immersion solution for more permanent, less expensive coating of printed circuits, metallized plastics, etc. with complete assurance of tarnish resistance and electrical resistivity. In a simplified immersion process, 24K gold is deposited by ionic displacement in a thin, dense, uniform protective layer. • Atomex is the first practical gold immersion solution containing no free cyanide. It eliminates need for costly analytical controls. Write for technical data.

CHEMICAL DIVISION
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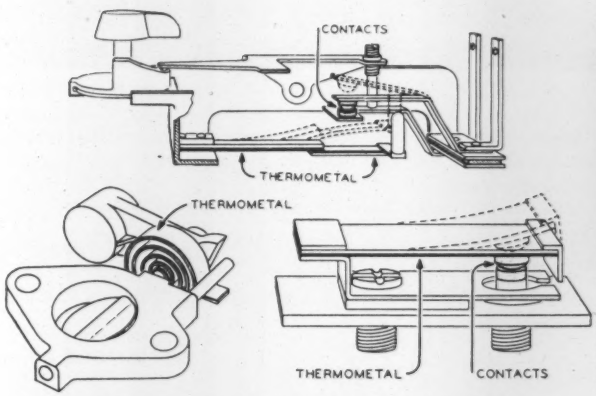

CONTROL TEMPERATURE, CURRENT AND VOLTAGE WITH THERMOMETAL®

Leading manufacturers rely on the dependable performance of Wilco Thermometal in electrical appliances, thermal cutouts, heating controls and many other applications involving the indication and accurate control of temperatures, electrical currents, voltages, etc. Thermometal is supplied in strip form, rolled and slit to close tolerances and tempered to specification. Thermometal elements and sub-assemblies are also supplied to specifications, with or without contacts attached. Send for literature.

H. A. WILSON DIVISION
U.S. HIGHWAY 22 • UNION, N. J.

FOR PLATINUM SPIRALS CIRCLE 36 ON READER-SERVICE CARD
FOR THERMOMETAL CIRCLE 37 ON READER-SERVICE CARD

ENGELHARD
INDUSTRIES, INC.
EXECUTIVE OFFICES:
113 ASTOR STREET • NEWARK 2 NEW JERSEY

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Please send literature as indicated below, addressed to my attention:

☐ Econotape ☐ Rhodium Plating
☐ Fine Wire ☐ SilvaBrite Silver Plating
☐ Platinum Spirals ☐ Atomex
☐ Thermometal

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TITLE.....
FIRM.....
STREET.....
CITY..... ZONE..... STATE.....

FOR IMMERSION GOLD CIRCLE 38 ON READER-SERVICE CARD

A NEW ADDITION TO THE SONAC *LINE*

POSITIVE ULTRASONIC LEVEL CONTROL

The components of Sonac (sensor actual Size)

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of SONAC sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the SONAC sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.

FIG. 1—LIQUID LEVEL (One Sensor)

FIG. 2—DRY LEVEL (Two Sensors)

For level control, SONAC is accurate to .005″ and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which SONAC can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because SONAC may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

Canadian Representative:

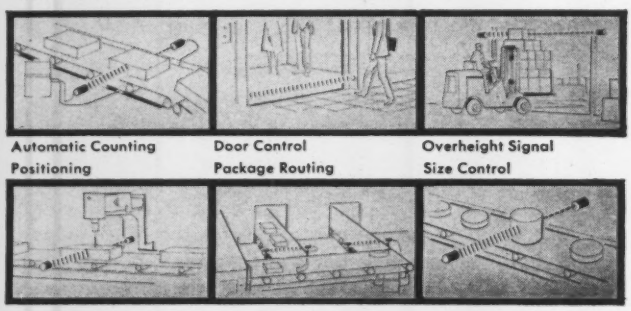
KNOWLES & FOSTER (North America) Ltd.

708 Terminal Bldg., Toronto 1, Ontario, Canada

SONAC is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from −425° F. to +450° F. They are immune to shock, vibration or mechanical damage.

The control is a compact unit 5″ x 5″ x 5″ and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.

Here's how SONAC can be used for sensing and switching applications other than level control.



Automatic Counting Positioning | Door Control Package Routing | Overheight Signal Size Control

There are dozens of applications for SONAC *single and double sensor units. Let it go to work for you now, write:*

DELAVAN Manufacturing Company

WEST DES MOINES • IOWA

A

CIRCLE 39 ON READER-SERVICE CARD

POST ELECTRONIC PRODUCTS and CONTROL SYSTEMS

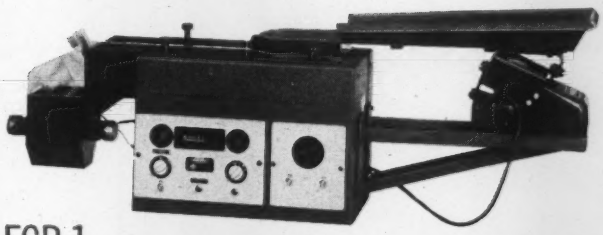
PROVIDE:

AUTOMATION • CONTROL • WATCH DOG RELIABILITY

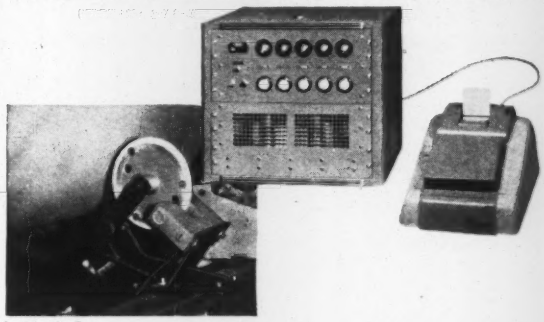
WIDESPREAD ACCEPTANCE is the best evidence of Post's contributions to measurement, and production control. A great variety of problems can be solved by Post electronic products . . . from "batch" counting to paper break detection.

Why not "ASK POST" for an analysis of your particular problem. We will be happy to help you find a solution.

TYPICAL POST DEVELOPMENTS*...



FCB-1 High speed, automatic, small parts counter-batcher. Portable —Feeds, counts and batches small parts, tablets, hardware, etc.

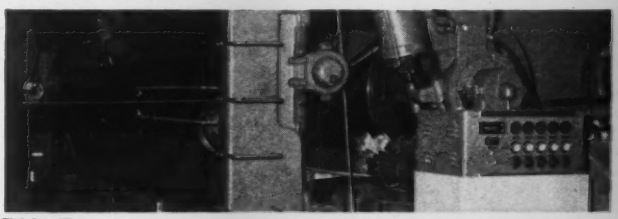


LF-1A Lineal footage measurement, electronically . . . Capable of length measuring continuous production items, i.e., paper, wire, rope, ribbon, etc.

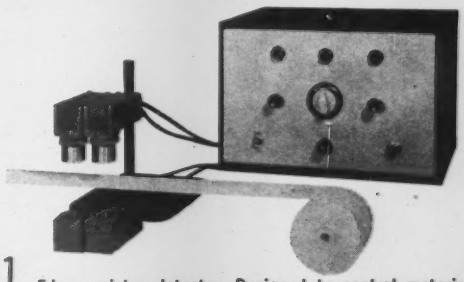
Features visual and printed readout.

P2-RM A preset type counter capable of counting batches in any desired quantity 1-100 (inclusive) with a built-in, 2 scale, rate meter calibrated in "thousands per hour".

PDC The Post "difference" counter . . . capable of maintaining counts of two (or more) variables and acting to control exact difference, i.e., shafts running at different RPM where it's important to maintain "difference" ratio. Many other applications. Adds, subtracts and visually indicates condition.



PW-5 Shown in paper making application. The counter is connected to a lineal footage measuring unit which accurately records paper production. Also provided is a "paper break detector" which will instantly shut off the machine should a web break occur.



ER-1 Edge register detector. Designed to control materials manufactured or processed in a web form. Detects web edge position with extreme accuracy. Inward or outward displacement of web actuates photoelectric control relays for correction.

Get full details on Post equipment today. Check the coupon below.

CIRCLE 40 ON READER-SERVICE CARD

**These are only a few of the many electronic counters and controls offered by...*

POST

ELECTRONIC PRODUCTS

Division of Reid Brothers Co., Inc.

17 LOTHROP STREET, BEVERLY, MASSACHUSETTS

Your special problems are earnestly requested!

Note: Complete line of production line counters available.

☐ FCB-1	Please send me the following product literature.
☐ LF-1A	
☐ P2-RM	NAME
☐ DFC	TITLE
☐ PW-5	COMPANY
☐ ER-1	ADDRESS
☐ Please have a representative call	

Assure peak performance for your process with

DEKORON®

Cabled Multicouple Extension Wire

featuring magnetic shield

Dekoron Type AT multiple pair harness thermocouple extension wire assures peak performance of your process now—and for years to come.

Magnetic shield—made of magnetic material only—protects process performance from magnetic and static interference, gives greater impact and crush resistance while maintaining easy installation. Number-coded twisted pairs speed field installation without elaborate testing. Chemical and moisture resistant construction lasts years longer.

Request a sample of Dekoron Type AT multicouple extension wire in Iron-Constantan, Chrome-Alumel, or Copper-Constantan today. It's application engineered by the company with the greatest backlog of application experience.

A-4051A

NO CONDUIT REQUIRED

Flexible Steel Armor
MAGNETIC-ELECTROSTATIC SHIELD

Number-Coded Pairs
INSTALL FASTER

Vinyl Outer Sheath
DIRECT-BURIAL APPROVED

Modified Square Lock Armor
MECHANICAL PROTECTION

Twisted Pairs
CANCEL OUT NOISE

Dekoron products

quality • research • service

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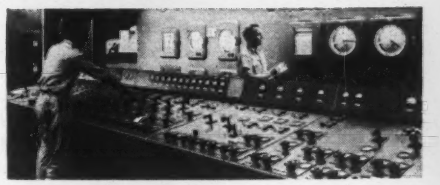


HAGAN NEWSLETTER—JULY

Behind the panel

HAGAN ALARM INDICATING MONITOR (AIM) GUARDS ATOMIC REACTOR

A Hagan AIM will monitor 75 temperatures on an atomic power reactor now under construction. Temperatures will range from 100F to 500F, and all are from condensers associated with the primary coolant loop. Combining all alarm functions in one instrument, the AIM will monitor any input which can be represented by DC voltages as low as 10 millivolts full scale, with an accuracy of plus or minus 0.1% full scale. The AIM provides maximum information on minimum panel space; the readout and alarm panel for 200 alarm points will fit into a 19" x 47½" panel area. (Details on request--ask for Item S-1)

ACCURATE POSITIONING--A MUST FOR DAMPERS ON TANGENTIALLY FIRED BOILERS

Several utilities have chosen the new Hagan 2½" x 5" Power Positioner to control secondary air dampers on new boilers now under construction. Reason--the superior accuracy and repeatability of the Hagan units. The electric operators previously used employ a braking device which is subject to variations in adjustment. Over a period of time, this variation could result in some dampers being wide open and others on the same unit almost closed. The Hagan Positioner avoids this possibility because no brake is needed for this pneumatic operator, and, in addition, each unit is individually controlled. All the control room operator has to do is turn the set point handle, and all the dampers move smoothly and accurately to the desired position. This exact position is held until the next signal is received. The Hagan 2½" x 5" Power Positioner is compact, simple and rugged. It is high speed--full 5" stroke in less than 2 seconds--and has a repeatability of plus or minus 0.3% of full scale. (Details on request--ask for Item S-2)

NET SOLIDS METERING SYSTEM SOLVES DREDGE PROBLEM

Here is a system that really paid for itself in the first month of operation. A dredging operation was to be paid in terms of the actual amount of solids removed. Before the Hagan system was installed, the dredges had been averaging only 40% of contract volume. Since the installation of the Hagan system, the dredges have been exceeding contract volume by 25 to 30%. The system measures fluid velocity and friction. By means of a series of automatic computations, actual net solids flow is derived. A recorder shows solids flow and corrected net solids density and integrates solids flow. Now operators can raise or lower the drag head to keep the net solids flow at maximum value at all times. Four such Hagan pneumatic systems have been installed on two barges. On order are four more systems that will operate in exactly the same manner as the pneumatic, but these will be Hagan PowrMag electronic controls. Actually, the electronic systems will be more accurate than the pneumatic, since the PowrMag system will be able to correct for dry solids. (Details on request--ask for Item S-3)

HAGAN CONTROL PACKAGE FOR BLAST FURNACE FUEL INJECTION

The steel industry, always on the lookout for better and more economical production methods, are pleased with the results obtained by the injection of hydrocarbon fuels into blast furnace tuyeres. Coke rates are reduced and iron production increased, and blast furnace operation is smoother. Hagan engineers have applied their wide experience in the steel industry to the development of a control system that makes the most of the advantages inherent in fuel injection. The system measures both blast air and fuel with a high degree of accuracy, since Hagan temperature and pressure compensated Ring Balance meters are used in this service, which overcomes the drastic metering errors of uncompensated devices. A simple ratioing loop, the Hagan system uses either electronic or pneumatic signals. Normal safety devices demanded by good practice are a part of the system. This control package can be made available on a schedule that meets most plant requirements. (Details on request--ask for Item S-4.)

HAGAN CHEMICALS & CONTROLS, INC., Hagan Center, Room 716, Pittsburgh 30, Pa.

HAGAN DIVISIONS: CALGON CO. — HALL LABORATORIES — BRUNER CORP.

CIRCLE 42 ON READER-SERVICE CARD

←——CIRCLE 41 ON READER-SERVICE CARD

Here's Take-Your-Choice Versatility

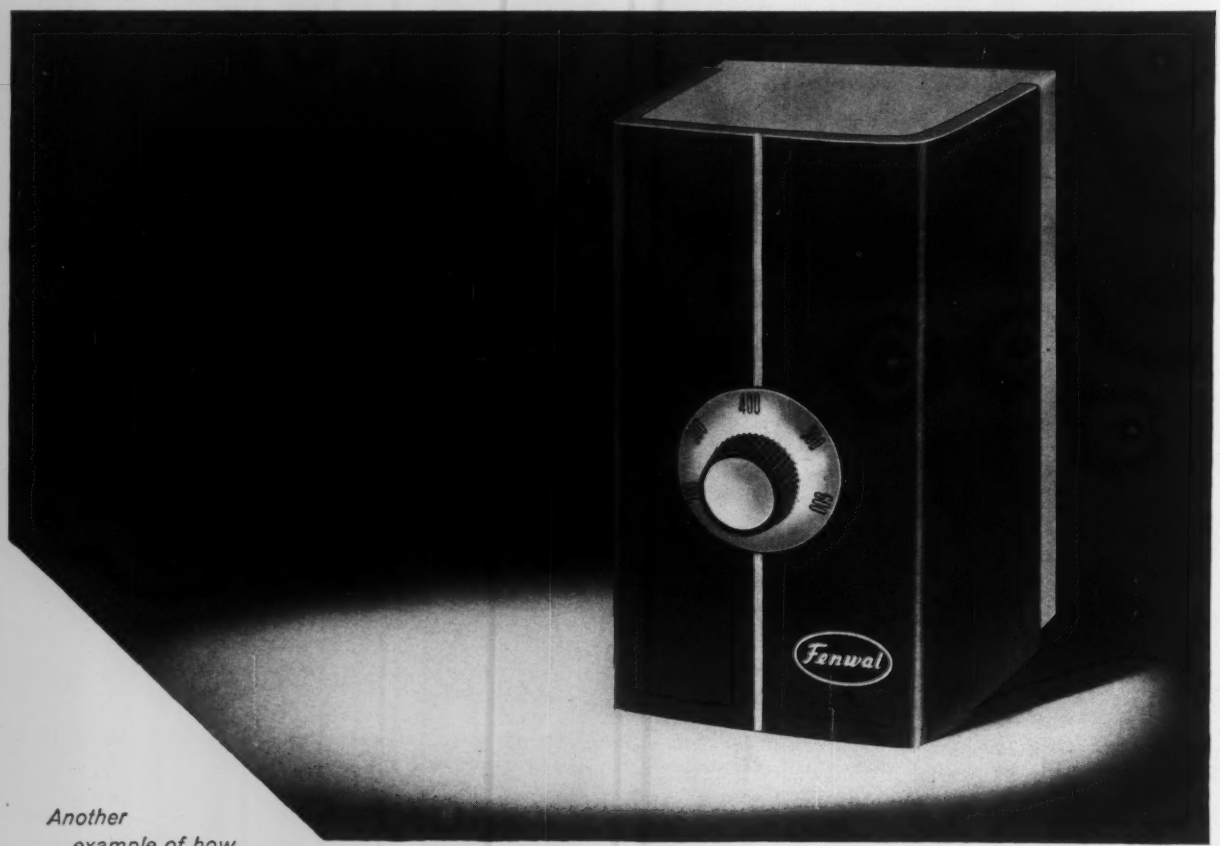
with the Multi-option Fenwal 536 Temperature Controller

It's so *precise* and yet so *easily adaptable* to an almost endless variety of temperature control applications, you become all but convinced that the transistorized Model 536 was engineered with only your needs in mind!

From its multi-option printed circuit board to its numerous interchangeable components, the Model 536 Temperature Controller spells *versatility*. ON/OFF or proportioning control . . . dial for set point adjustment mounted externally or internally . . . expanded scales for precise temperature adjustment — the 536 offers all these advantages! Five standard temperature ranges from −50 to +600°F . . . separate potentiometer with graduated dial and knob for remote temperature adjustment . . . capacity of 10 amp/110 VAC and 5 amp/230 VAC . . . these choices are also available to you. *And you pay only for the options you need!*

The 536 is sensitive to within 0.1F°. And if you wish to build a multi-point control and indication system — either gradually or all at one given time — you simply combine the Fenwal Model 580 Temperature Indicator with as many 536 Controllers as you require. Thermistor sensors enable fast response and ordinary copper lead wire may be used for connections. Removable interior of the Model 536 allows easy, safe installation and the instruments are smartly styled to perfectly complement modern industrial machines and interiors.

Find out more about how the precise Model 536 Temperature Controller can be adapted to your exact needs by writing to FENWAL INCORPORATED, 367 Pleasant St., Ashland, Mass. Request Bulletin MC-195.

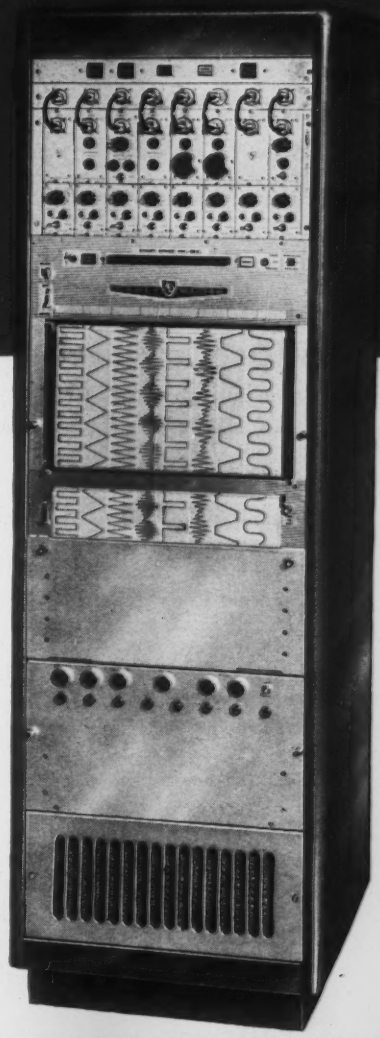


Another example of how

Fenwal CONTROLS TEMPERATURE . . . PRECISELY

CIRCLE 43 ON READER-SERVICE CARD

Here's why the NEW AO TRACE-MASTER is the world's finest 8-channel direct writing recorder!



American Optical Company, famous for precision instrumentation for over 100 years, introduces an electronic direct-writing recorder of unique design, in which ultra-precise electromechanics has been combined with advanced electronics to achieve *truly superior performance.*

Finest Writing Method Ever

Unique direct-carbon-transfer writing method. Trace is uniformly black and up to four times thinner than that made by any other recorder. Minute variations in phenomena measured are more faithful, meaningful. Carbon trace cannot fade... may be easily reproduced.

Finest Frequency-Amplitude Performance

TRACE-MASTER'S multiple-feedback wide-range Driver circuitry, combined with the advanced pen-motor design, produces wider frequency response *at larger amplitudes* than any other recorder. TRACE-MASTER response is flat—*within 1%*—from dc to 110 cps at 40 mm!

Band Amplitude Product (i.e. Bandwidth times Amplitude) is 5600...140 cps (3 db point) x 40mm!

Finest Chart-Drive Facilities

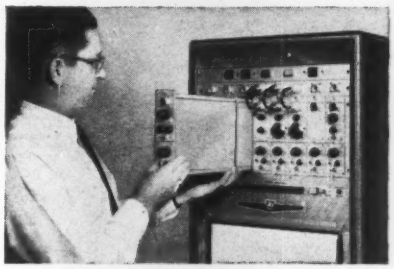
TRACE-MASTER provides widest chart-speed range...0.1 to 500 mm/sec...of any direct-writing recorder! Convenient push-button selection. Take-up reel automatically stores full 1000 ft. record. Writing table tilts for easy chart annotations. Guide rails permit quick, easy paper-roll changes. Low cost chart paper makes practical protracted recording at high speeds.

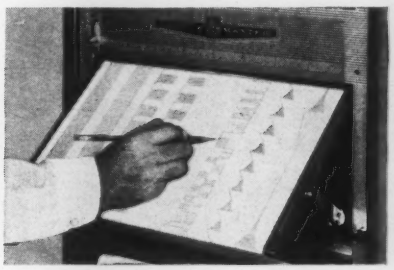
Finest Resolution, Linearity, Stability

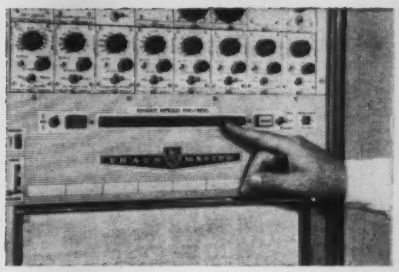
Thin carbon trace (thinner by 4 to 1 over most recorders) and high Band Amplitude Product (higher by 6 to 1 over other recorders) provide up to 24 times the resolving power or ability to detect short, sharp variations in the record. The superior linearity (± 1%) and stability in rectilinear presentation permit full use of this unexcelled resolution.

Finest Systems Oriented Compatability

Fully transistorized circuitry...application of combined dc level and signal multiple feedback...complete interchangeability of modular signal-conditioning elements... are some of the features that make the AO TRACE-MASTER the world's finest 8-channel direct writing recorder.



Entire channel easily accessible and completely interchangeable as single unit.

Platen tilts to convenient writing angle.



Widest range chart speed . . . push-button selection through 0.1 mm/sec to 500 mm/sec.

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American Optical COMPANY

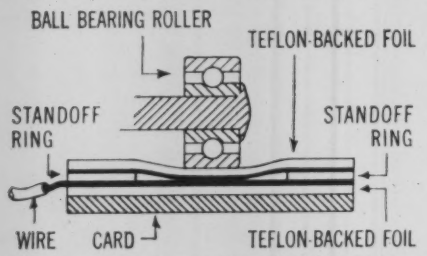
INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

CIRCLE 44 ON READER-SERVICE CARD

BRIEFS

Rolling-Contact Commutator

Designed for rocket-satellite telemetry systems, the Model 6-15 has, in a number of cases, made it possible to eliminate amplification stages prior to commutation. Noise level is guaranteed less than 10 microvolts



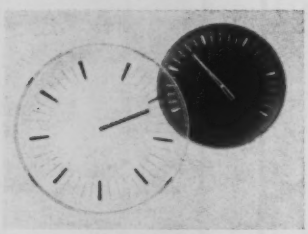
(10 microvolts is the lowest bound of the testing equipment; however, the noise level is probably far below the limits of the equipment) at 1-kilocycle bandwidth under 1000 ohms load in the range of 6 volts to 50 microvolts . . .

A rolling depressor is used to effect contact pressure for pickup. This is accomplished by having the pressure placed against a flexible diaphragm which, in turn, forces two pieces of foil together to make contact . . . Contact between the segments is accomplished by depressing the teflon-backed foil through the use of a miniature, precision, rolling bearing's pressure. The rolling pressure creates a dimple in the foil which, in turn, makes a low noise and highly reliable contact. By virtue of its design, high speeds are possible . . . (*From new 4-page bulletin, Technology Instrument Corp., 533 Main St., Acton, Mass.*)

FOR THIS LITERATURE CIRCLE 201 ON READER-SERVICE CARD

Thermoplastic for Dials

Bavick-11 . . . molds to close tolerances for windows, pointers, dial faces and indicator lamp covers. Retains shape, dimensions, and clarity at elevated temperatures or in hot-cold temperature cycling tests

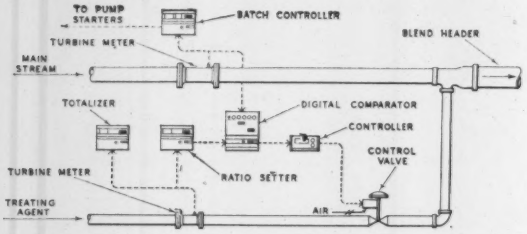


despite heat from nearby incandescent bulbs or corrosive chemical fumes . . . Has superior chemical and solvent resistance compared to other water-white transparent plastics. It is especially resistant to alcohols, mineral acids, strong alkalies, aliphatic hydrocarbons, fatty acids, organic acids, essential oils and detergents . . . (*From new 4-page bulletin, Plastic Div., J. T. Baker Chemical Co., Phillipsburg, N. J.*)

FOR THIS LITERATURE CIRCLE 202 ON READER-SERVICE CARD

In-Line Blending System

Typical variations in the blending systems offered include . . . Multi-stream systems where a variable frequency oscillator provides a master pulse reference. Desired total system flow rate can be set directly in engineering units such as gpm or barrels/hour. The



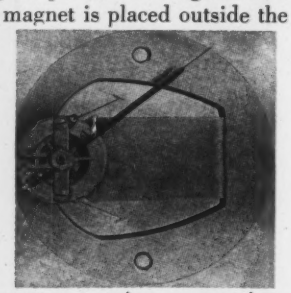
proportion that each component is to represent of the total blend is set directly as a percentage. Total flow of each component is also measured and displayed . . . There are five basic components common to all systems: (1) turbine flowmeters . . . (2) digital comparators . . . (3) ratio setters . . . (4) electronic controllers . . . (5) diaphragm motor valves.

The system operates as follows: if the total quantity ratio of the two flows is the correct value, as determined by the ratio setter, the digital comparator will receive a zero count signal . . . However, if main stream flow (A) starts to increase, for example, the digital comparator will immediately see the count difference, indicating the need for an equivalent increase in flow B counts to return the system to zero count difference . . . A batch controller is connected to the turbine meter on the main stream line to shut off the pumps on both lines after a preset total flow. A direct reading totalizer is connected to the turbine meter on the treating agent line to totalize this flow . . . (*From new 11-page publicity release, Fischer & Porter Co., 801 Jacksonville Rd., Warminster, Pa.*)

FOR THIS LITERATURE CIRCLE 203 ON READER-SERVICE CARD

Ring Bar Panel Meters

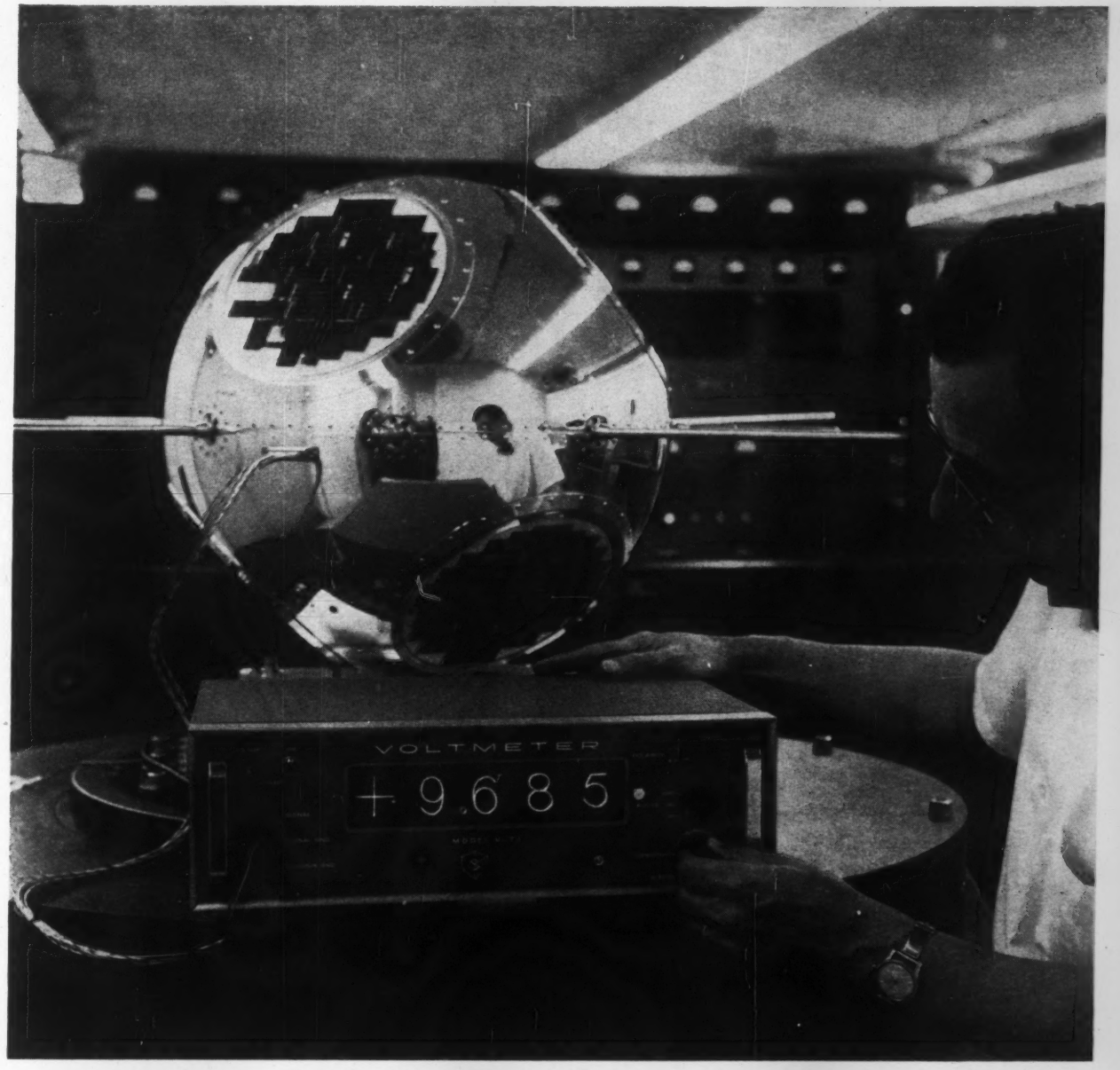
The ring bar mechanism makes use of the standard d'Arsonval movement, with one exception. That exception being the permanent magnet. In this movement a permanent magnet is placed outside the coil housing



but the entire magnet and movement is surrounded by a heavy ring of soft iron as pictured. The use of this type mechanism allows great versatility in sensitivity as well as complete magnetic shielding. When utilizing the ring bar movement it is possible to attain sensitivities up to 100,000 ohms/volt, or full scale deflection of 10 microamps . . . (*From new 24-page "Panel Instruments" catalog, Rowan Controller Co., Red Bank, N. J.*)

FOR THIS LITERATURE CIRCLE 204 ON READER-SERVICE CARD

(*Continued on page* 1198)



NEW DVM CONCEPT!

FAST: *Two readings per second* ***ACCURATE:*** *0.01% accuracy* ***LOW COST:*** *Only $1,580*

In the above test of a satellite's telemetry and solar cells, it was necessary to make 100 accurate measurements every minute. The job was done with the new Cubic V-70 digital voltmeter that reads out four times as fast as any instrument with stepping switches. The V-70 uses ultra-reliable reed relays hermetically sealed in glass for a life expectancy of at least 10 years. It has no moving parts, requires no maintenance, will operate in any position, and is resistant to thermal and physical shock. The V-70 is the only DVM offering 0.01% accuracy and less than 1 second balance time for less than $2,000 (Model V-70, $1,580; Model V-71 with automatic ranging and polarity, $2,200). For details, write to Dept. IC-106.

cubic CORPORATION
INDUSTRIAL DIVISION
SAN DIEGO 11, CALIFORNIA

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CIRCLE 45 ON READER-SERVICE CARD

DIALCO® PILOT LIGHTS

with Built-in Resistor
(a patented DIALCO feature)
for the Neon Glow Lamp NE-51H (High Brightness)

RUGGED: The NE-51H Neon Glow Lamp is made to resist vibration and is proof against sudden failure. It may be operated at about 3 times the level of current applied to the standard neon lamp, and it will produce 8 times as much light—*with long life!* Requires low power—less than 1 watt on 250 V circuit. Recommended for AC service (may be used on DC circuits above 160 V).

BUILT-IN current-limiting resistor (U.S. Patent No. 2,421,321): For use on 105-125 volt and 210-250 volt circuits. In DIALCO Pilot Lights, the built-in resistor is completely insulated in moulded phenolic and sealed in metal.

COMPACT: Units are available for mounting in 9/16" and 11/16" clearance holes... in a wide choice of lens styles and colors, terminal types, metal finishes, etc. Meet applicable MIL Spec and UL and CSA requirements.

Every assembly is available complete with lamp.

SAMPLES ON REQUEST—AT ONCE—NO CHARGE

Ask for Bulletin No. 100 and Catalogue L-161B.

Foremost Manufacturer of Pilot Lights
DIALIGHT CORPORATION

42 STEWART AVE., BROOKLYN 37, N. Y. • HYacinth 7-7600
Booths 2519-2521 at the WESCON Show
CIRCLE 46 ON READER-SERVICE CARD

Position-to-digital Encoders

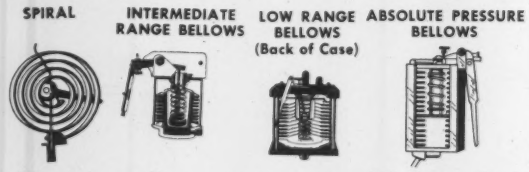
The new noncontact encoder, using proven computer techniques, converts a coded change in a magnetic field to a variable AC signal. This signal can be electronically converted to a natural binary readout. Ambiguity is avoided in true binary readouts through the use of double V-scanning heads in each

track . . . New miniaturization techniques allow size reduction for airborne and other minimal applications . . . Specifications—Output Code: natural binary. Resolution: (per input shaft turn) 128 counts. Full Scale Capacity: 7 bits, 13 bits. Speed: operating 200 rpm, slew 1,300 rpm. Starting Torque: 0.5 oz-in, maximum. Diameter: 0.750." Weight: 3 ounces . . . . (*From new 4-page bulletin Librascope Div., General Precision, Inc., 100 East Tujunga, Burbank, Calif.*)

FOR THIS LITERATURE CIRCLE 205 ON READER-SERVICE CARD

Pressure Elements

The *spiral pressure element* is a thin walled tube which has been flattened on opposite sides to produce an approximately elliptical cross section before being wound as a flat spiral. When pressure is applied, the tube tends to uncoil . . .



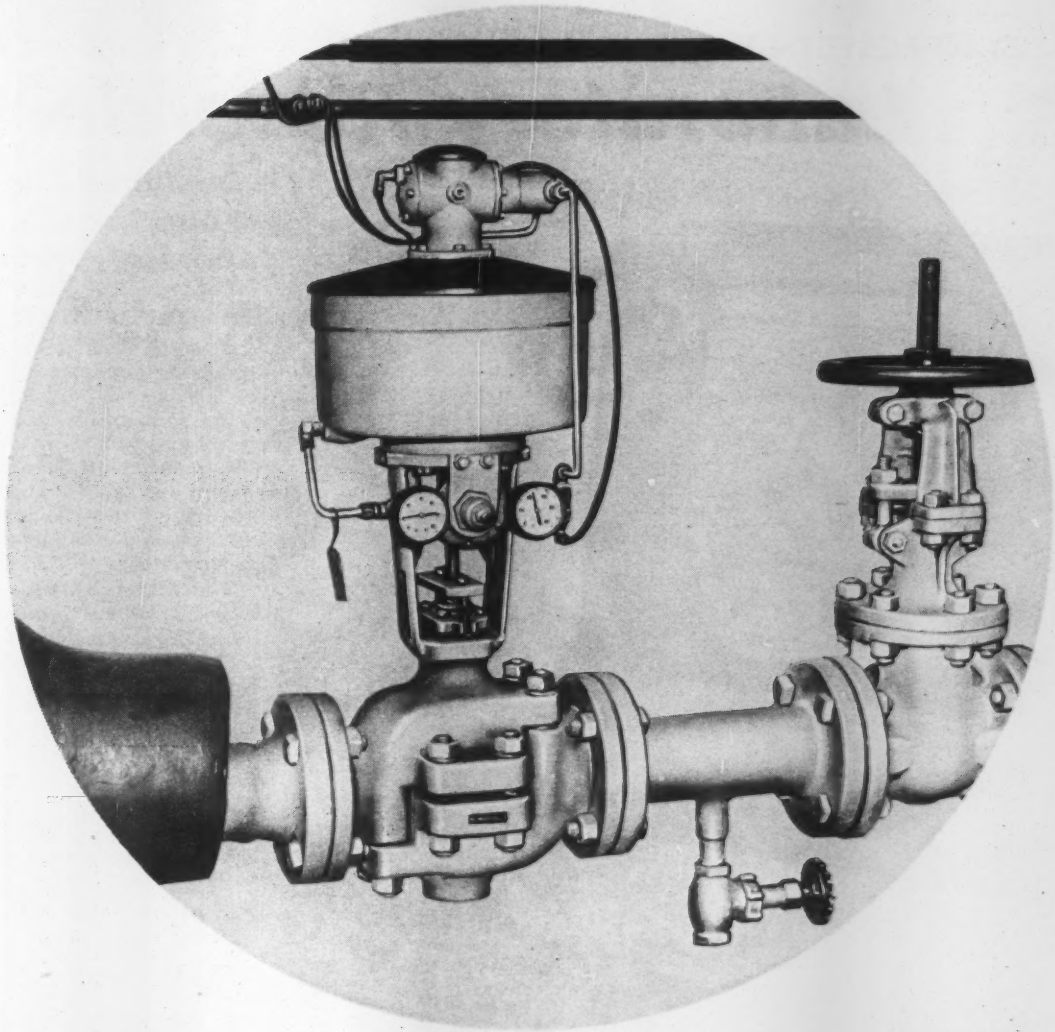
The *intermediate range spring and bellows element* is used for lower pressure ranges than the spiral elements. It is a spring loaded metal bellows enclosed in a shell which is connected to the pressure source. Pressure compresses the bellows forcing its lower end upward against the opposing force of the spring . . .

Low-range spring and bellows . . . element is used for minimum full scale pressures of 5 inches of water up to 90 inches of water and vacuums of 5 to 60 inches of water or compound ranges of 5 to 80 inches of water. The extra large spring and bellows element is mounted on the back of the case . . .

The use of *absolute pressure gages* is generally confined to the accurate pressure low enough to be seriously affected by barometric pressure variations . . . A yoke connects two opposed bellows to the pen shaft. The upper bellows, which contains the actuating spring, is evacuated to a fraction of a millimeter of mercury pressure absolute and sealed . . . (*From new 36-page Catalog C70-1a, "Pressure and Vacuum Gages," Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Phila. 44, Pa.*)

FOR THIS LITERATURE CIRCLE 206 ON READER-SERVICE CARD

(*Continued on page* 1202)



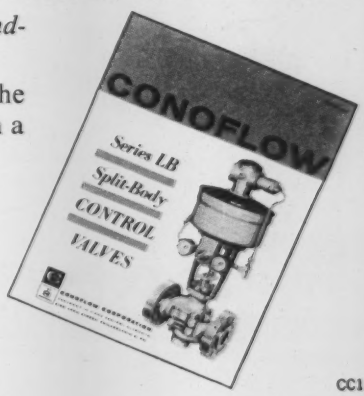
A Split-body Valve is not a "Specialty"

...it is a practical, all-purpose control valve

The Conoflow Series LB valve shown is handling 100 psi steam. This is not unusual. Actually, the vast majority of the thousands of LB valves in service are handling water, steam and other common plant fluids. In fact, more than 80% of LB orders call for *standard* cast steel or ductile iron construction.

LB valves were selected because they give *better control, greater dependability* and *unequalled maintenance savings,* all at a *low initial cost.*

More and more users are standardizing on the LB valve right down the line because they know that LB valves mean *less downtime,* resulting in a more profitable plant operation.



Write for NEW Bulletin LB-4. Be convinced.

CONOFLOW SUBSIDIARY WALWORTH

CONOFLOW CORPORATION

FOREMOST IN FINAL CONTROL ELEMENTS

2100 ARCH STREET, PHILADELPHIA 3, PA.

CC110

CIRCLE 47 ON READER-SERVICE CARD

SARGENT

Laboratory Recorders

Designed For Your Specific Laboratory Needs

Model MR

The Model "MR" Recorder

Here is the ultimate in recorders designed exclusively for almost all measurements commonly made in the chemical laboratory. This instrument measures current and voltage and all other quantities which can be transposed into potential or current signals.

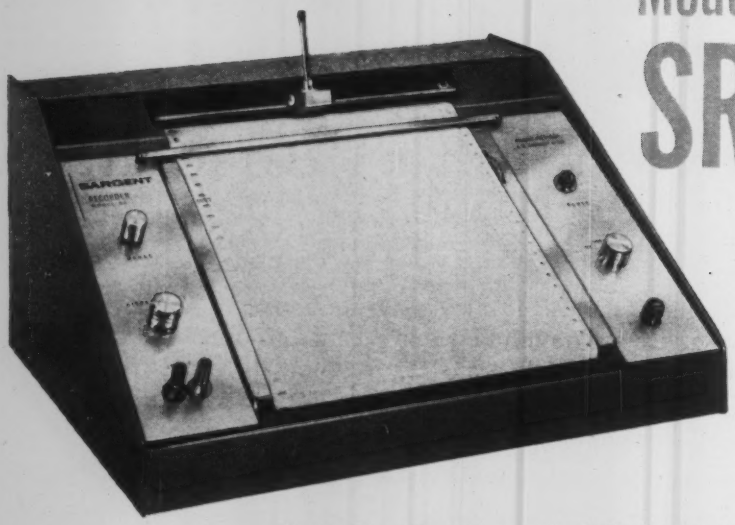
The Model "MR" features: 31 Potentiometric Ranges; 9 Chart Speeds, or 27 Chart Speeds with the Sargent Ratio Multiplier Attachment; and it is designed for laboratory bench operation.

S-72150 Sargent Recorder
(Pat. No. 2,931,964).....$1725.00

S-72151 Sargent Recorder
with Ratio Multiplier Attachment, 27 Chart Speeds.....$1775.00

For complete specifications write for Bulletin R

Model SR



The Model "SR" Recorder

Sargent offers the Model SR to fill the need for a low cost recorder that features: maximum accuracy at a minimum cost; 250 mm width chart; fast balancing speed of 1 second; high sensitivity, high gain amplifier; and square cornering at 10,000 to 50,000 ohms input. This instrument provides the minimum required flexibility at the lowest possible cost.

S-72180 Sargent Recorder
(Pat. No. 2,931,964)..... $675.00

For complete specifications write for Bulletin SR-B

Designed and Manufactured by E. H. Sargent & Co.

SARGENT SCIENTIFIC LABORATORY INSTRUMENTS • APPARATUS • SUPPLIES • CHEMICALS

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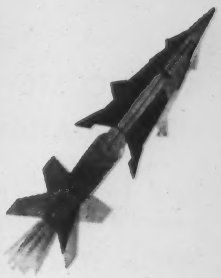
DETROIT 4, MICH. • DALLAS 35, TEXAS • BIRMINGHAM 4, ALA. • SPRINGFIELD, N.J.
CIRCLE 48 ON READER-SERVICE CARD



New
Improved
Lino-Writ 5
Use it as
a direct
writing paper
or develop it
with new
processing kit

Lino-Writ 5, proved the most dependable direct writing photo-recording paper you can use, now adds a new bonus: you can use it as a completely dry process paper, or you can process it, for permanent trace results, with Du Pont's new Direct Writing Paper Processing Chemicals Kit.

Improved Lino-Writ 5 is still outstanding for dry-processed image stability and requires no stabilizing treatment for handling under normal room light conditions. Records may now be processed for greater permanence, for making reproductions with diazo equipment or for handling for prolonged periods under intense lighting.

Improved Lino-Writ 5: up to 100,000 ips... easy-to-read traces ... and now, use it either dry or wet process.

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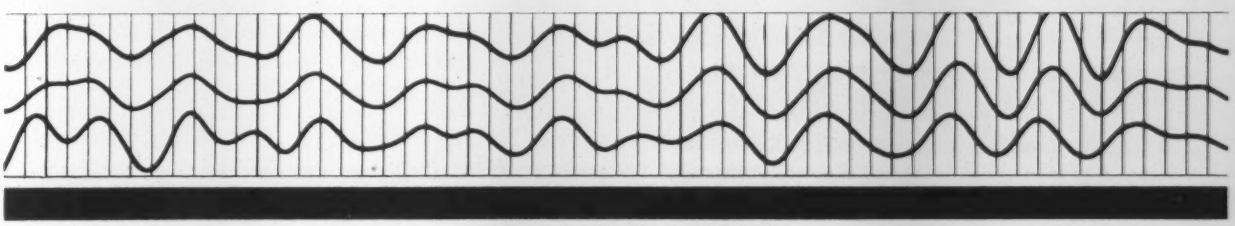
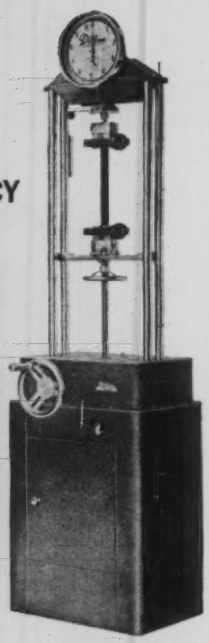
E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Del. In Canada: Du Pont of Canada Ltd., Toronto



CIRCLE 49 ON READER-SERVICE CARD

AVOID COSTLY ERRORS
WITH **GUARANTEED**
Dillon **ACCURACY**
WHEN YOU...

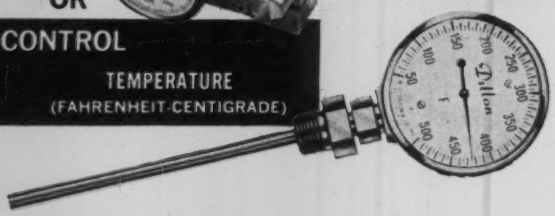


TEST...
In TENSILE • COMPRESSION
TRANSVERSE • SHEAR

MEASURE...
In TENSION OR COMPRESSION

OR

CONTROL
TEMPERATURE
(FAHRENHEIT-CENTIGRADE)



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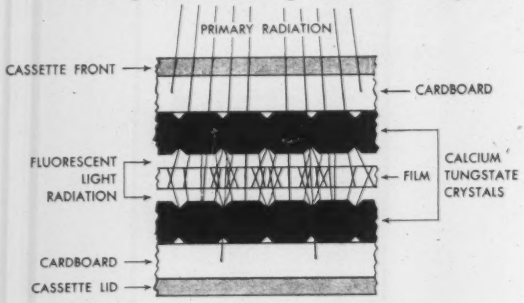
CIRCLE 50 ON READER-SERVICE CARD

Industrial X-ray Intensifying Screens

The "Patterson" No. 245 Industrial Screen . . . is formulated to give maximum response to the hard, short-wave-length radiation generated at high kilo-



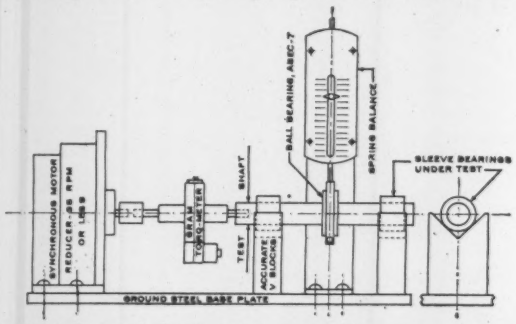
FILM IS EXPOSED BY BOTH PRIMARY RADIATION AND FLUORESCENT LIGHT RADIATION

voltages. Its speed not only cuts exposure time, but reduces tube wear. The advantage of the "Patterson" No. 245 Combination over conventional, medical-type intensifying screens is readily noticeable in the radiography of metals and other dense materials above 85 KvP. The speed advantage increases rapidly as the kilovoltage and the thickness of the interposed metal are increased. This screen is adaptable for use up to 400 KvP . . . (*From 24-page Booklet A9234, E. I. DuPont de Nemours & Co., Inc., Wilmington 98, Del.*)

FOR THIS LITERATURE CIRCLE 207 ON READER-SERVICE CARD

Torque Testing Methods

Static torque tests are simple and usually require only that the Torqmeter be attached to the shaft and a reading taken at the torque point at which the shaft



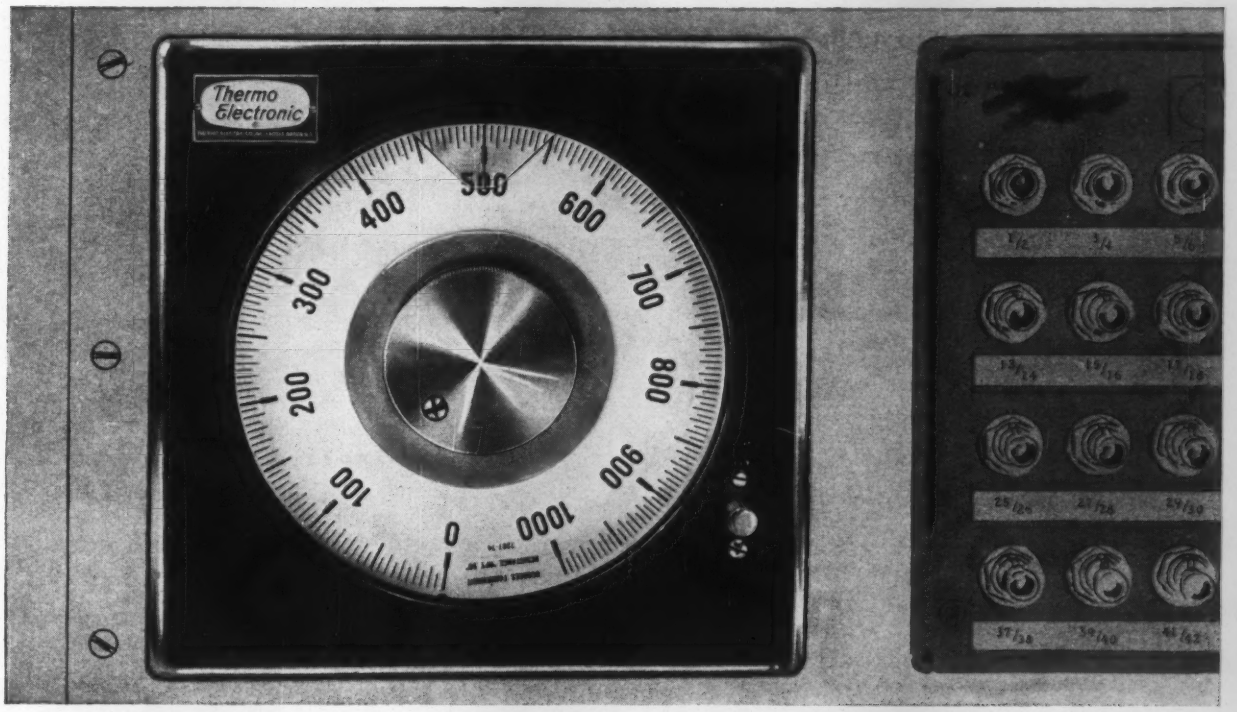
(or tested part) begins to move. The most common tests of this kind are "Starting Torques" of plain bearings, ball bearings, generators, potentiometers, etc.

Rotating torque tests are more difficult and become increasingly so as speed is increased. Increased speed usually means increased vibration accompanied by pulsation and other periodic phenomena. On the other hand, non-uniformities in construction will show up at slow speeds that cannot be detected at high speed . . . We therefore recommend: Unless the effects of speed are an object of the test, all rotating torque tests should be made at lowest practical speed . . . (*From 12-page brochure, "Torque and Efficiency Measurements," Power Instruments, Inc., 7352 N. Lawndale Ave., Skokie, Ill.*)

FOR THIS LITERATURE CIRCLE 208 ON READER-SERVICE CARD

(*Continued on page* 1204)

do you need this Thermo Electronic Self-Balancing Indicator...?



You do if you need...

Compactness – Requires just a 7½" square of your panel space, yet has long, legible 16" dial.

Versatility – Bridge or Potentiometer type temperature measuring indicators adapt to almost any process – easily changed ranges and calibrations – available with two or three position controls. Multi-point Switches permit connection to unlimited number of sensing elements.

Fast Response—
Automatic, self-balancing, 2.5 seconds full scale travel.

Accuracy – Guaranteed ±0.25% of full scale – constantly maintained over long periods without adjustment, even under adverse operating conditions. Sensitivity, 0.125%!

Easy Maintenance – Fully gasketed, black-enameled case, sealed against atmosphere, dirt, contaminants. Pull-out chassis permits easy cleaning, inspection, adjustment. Constant voltage supply eliminates standardization and battery replacement.

Thermo Electric

Temperature Measuring Systems and Components

GET FULL DETAILS on the Thermo Electronic Self-Balancing Indicator. Write for Instrument Section 67 — 12

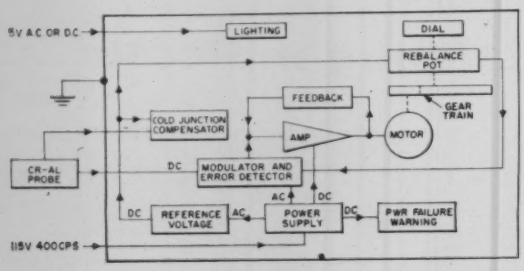
20 YEARS

THERMO ELECTRIC Co., Inc., Saddle Brook, New Jersey
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

CIRCLE 51 ON READER-SERVICE CARD

Temperature Servo Indicator

Con-temp DST Series thermocouple or Resistance Bulb Type Servo Indicator (is) designed to your exact system requirements . . . for measuring and/or

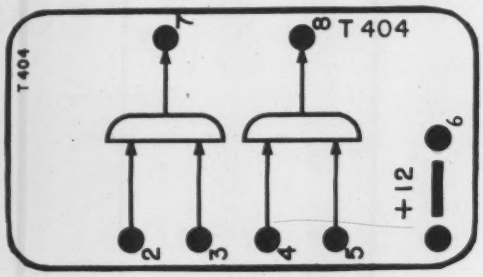


monitoring temperature, pressure and other variables accurately and reliably . . . Heart of this unique capability is Conair's proven servo-driven, self-balancing potentiometer type bridge system. Compact and fully transistorized, this highly stable indicator/amplifier unit gives instantaneous indications, with no warm-up lag. Exceeding all critical environmental specifications, its simplified modular construction assures minimum size and weight, as well as easy maintenance . . . (*From new 6-page Spec Sheet DST-461, Conair (Consolidated Airborne Systems, Inc.), 900 Third Ave., New Hyde Park, L.I., N. Y.*)

FOR THIS LITERATURE CIRCLE 209 ON READER-SERVICE CARD

Transistor Circuit Modules

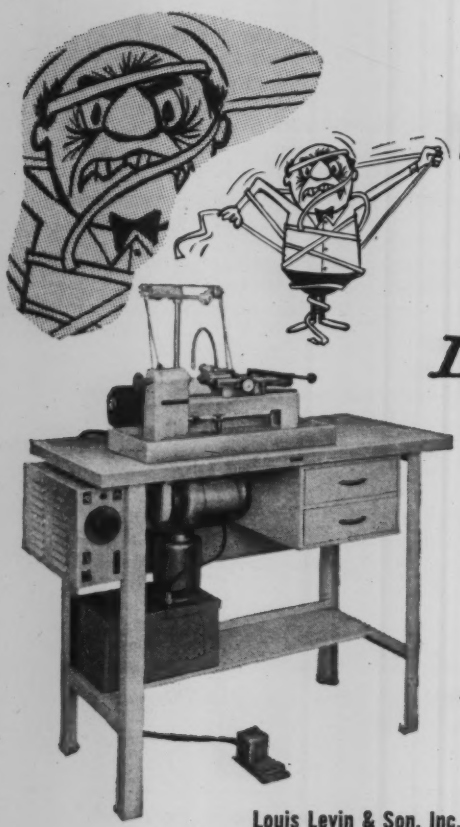
T-Series Digital System Breadboard Equipment can be built up in stages to any degree of complexity. Compatible interconnections between racks permit expanding equipment into a complete systems develop-



ment console . . . Plastic circuit cards, showing circuit symbols, input and output connections, power connections, part number, application notes, etc., provide a convenient guide to patchcord wiring of signal connections; facilitate drawing a circuit . . . *New 8-page "Loading Manual," containing Load Chart for transistor circuit modules, Engineered Electronics Co., 1441 East Chestnut Ave., Santa Ana, Calif.*)

FOR THIS LITERATURE CIRCLE 210 ON READER-SERVICE CARD

(*Continued on page* 1206)



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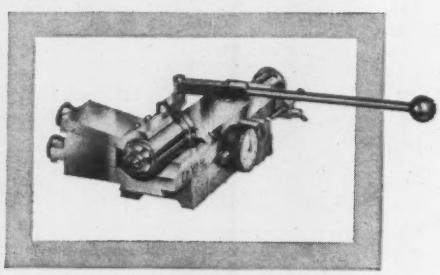
DRILL MICRO-HOLES*

DOWN TO .0016" with SPEED & ACCURACY

LEVIN ® MICRO-DRILLING MACHINE

Designed for the most precise drilling of small holes. The drilling spindle, as well as the head stock spindle, revolves and thus the maximum straightness and concentricity are assured. The feed is so arranged that it does not depend on the operator's sense of feel and the smallest drills may be safely used.



* Smallest commercial drill available.

For full details of Drilling Machine and Instrument Lathes send for catalog T.

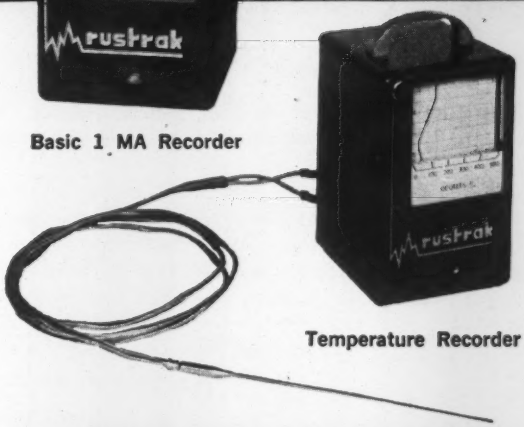
Louis Levin & Son, Inc., 3573 Hayden Ave., Culver City, Calif.

CIRCLE 52 ON READER-SERVICE CARD

rustrak

ONE SOURCE FOR ALL YOUR RECORDING NEEDS

Basic 1 MA Recorder



Temperature Recorder

★ Miniaturized ★ Automatic
★ Portable or Panel Mounting
★ Distortion Free, Smudgeproof Line

SINGLE CHANNEL RECORDER
From $79.50 to $104.95

DUAL CHANNEL RECORDER
From $124.50

TEMPERATURE RECORDER
$139.50

MODEL 113 AC POWER TESTER AND RECORDER
$195.00

AC CURRENT RECORDER
$105.00

EXPAND YOUR RECORDER CAPABILITIES with RUSTRAK ADD-ON ACCESSORIES

111-A MULTI-RANGER
1-5-10-50-100-500-1000 volts
$44.50

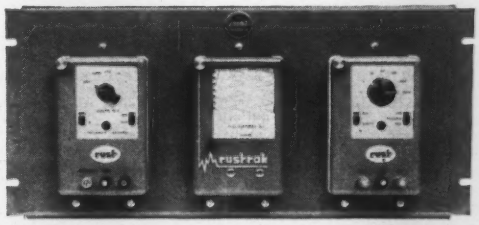
111-B MULTI-RANGER
3-15-30-75-150-300-750 volts
$44.50

110 DECADE AMPLIFIER
Vacuum tube type. 1-10-100-1000 volts D. C.
$79.50

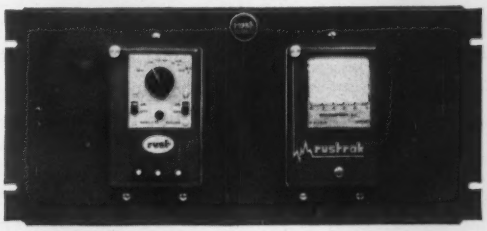
98 DC AMPLIFIER
Chopper stabilized, vacuum tube type. Full scale sensitivity: 10 Mv, 100 Mv, 1 volt, 10 volts, 100 volts or 1, 10, 100 μa
$109.50

114 AMPLIFIER
Vacuum tube, chopper stabilized.
Input impedance: 100,000Ω.
Output impedance: 0-5000Ω factory adjusted for 100Ω.
$110.00

The complete Rustrak line is available nationwide.



Dual Channel Recorder with 110 Decade Amplifier connected to left hand channel and a 111-A Multi-Ranger connected to the right hand channel. This combination allows simultaneous measurement of two individual signals.



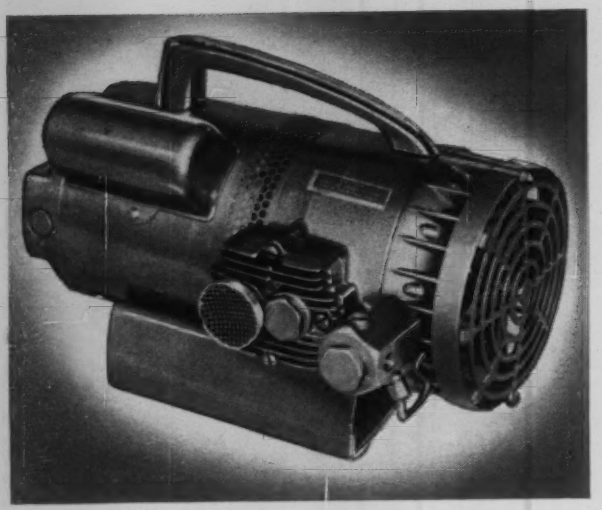
98 DC Amplifier connected to a standard 1 mil recorder, giving a minimum full scale sensitivity of .01 volt with an input resistance of 1 megohm. This combination provides a multitude of measurements.

For full information write

rustrak® INSTRUMENT COMPANY, INC.

130 SILVER STREET
MANCHESTER, NEW HAMPSHIRE

CIRCLE 53 ON READER-SERVICE CARD



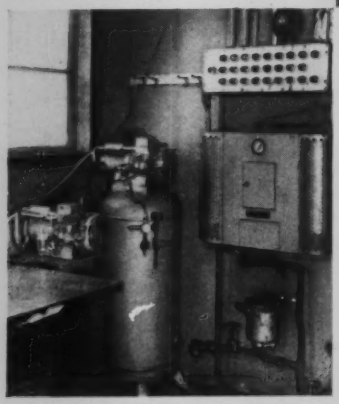
Oil-Free AIR FOR INSTRUMENTATION

For instrument control with compressed air, patented B&G Oil-less Compressors offer outstanding, exclusive advantages.

They deliver air *completely oil-free!* Carbon-graphite piston rings and skirts need no lubrication; bearings are grease-packed and sealed for life. Numerous design and construction features assure dependable delivery of cleaner, cooler, drier air and smoother operation.

B&G Oil-less Compressors can be located at the site of the control, eliminating long pipe lines which may contaminate the air with dirt and condensation.

Available in 58 models... portable, tank mounted, motor and gas-engine driven, 1/12 to 3/4 H.P., up to 6.57 CFM, up to 190 psi. Vacuum: 27.5".



Typical application to air drier

MINIATURE!

1/12 H.P. Oil-less Motor Compressor and Vacuum Pump

Fits in the palm of your hand, yet delivers much more free air than any current design of the same horsepower. It is capable of continuous operation at pressures up to 65 psi.—has infinite applications for instrument control, process agitation and motive power.

Oil-less **AIR COMPRESSORS**

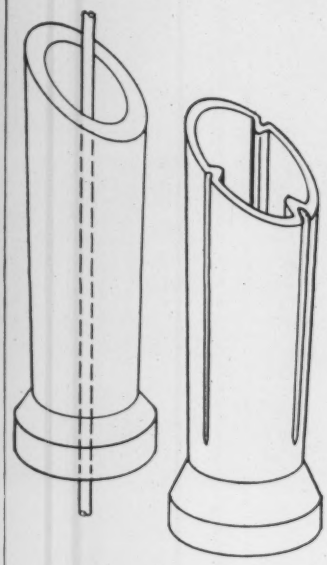
BELL & GOSSETT COMPANY

Dept. GS-84, Morton Grove, Illinois

CIRCLE 54 ON READER-SERVICE CARD

Varea-Meters

The W&T Glass-tube Varea-meter is an improved version of the time-proven variable-area flow meter.



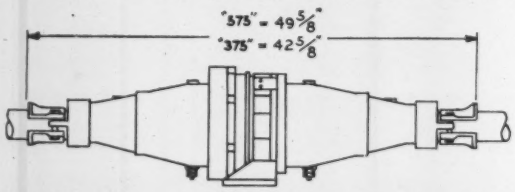
Substantial improvements have been made in tube, float and frame construction . . . They are simple—metering flow directly without secondary measuring devices such as manometers. They provide instantaneous, visual indication of flow. No special piping arrangements are required. Varea-meters operate with a low pressure drop, an important feature when pressure head is at a premium. They respond equally as well to small as to large flow rates. Standard accuracy is ±2%, but custom calibration to ±1% is available. Operating range is 10 to 1 or better. Readings are essentially independent of viscosity over a considerable range . . .

Varea-meter tubes are supplied in two types—plain and with beaded guide. They are equally suitable for most services. However, where slurries or suspended abrasives are involved and for opaque liquids, the beaded tube is preferable. The plain tube with rod-guided float is recommended when there is vibration or surging . . . (*From new* 20-*page Catalog* 520.100, *Wallace & Tiernan Inc.*, 25 *Main St., Belleville* 9, *N. J.*)

FOR THIS LITERATURE CIRCLE 211 ON READER-SERVICE CARD

Cable Couplers

Type AC Cable Couplers provide safe, convenient means for connecting portable cable, rated 7500 volts and less, to mining equipment, electric shovels, portable substations, portable junction boxes or similar applications. They may also be used for joining lengths of high-voltage cable . . . Plug and socket each contain three contacts for conducting power and one for shielding and/or ground wires. Contacts are mounted in and insulated by a single-piece, heavy-duty, pressure-molded insulator . . . Positive thread engagement of metal housing during contact make or break . . . (*From new* 6-*page catalog* 3751.1, *PLM Products, Inc.*, 3871 *West* 150*th St., Cleveland* 11, *Ohio.*)



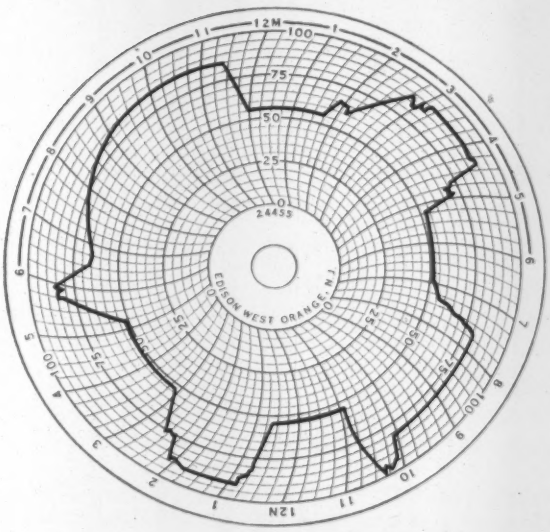
FOR THIS LITERATURE CIRCLE 212 ON READER-SERVICE CARD

(*Continued on page* 1210)

NEW FROM EDISON . . .

OMNICORDER

A PRECISE MINIATURE INKLESS RECORDER



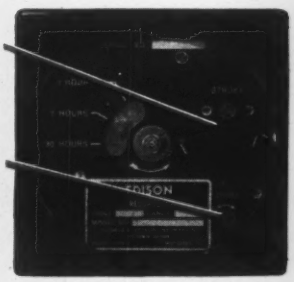
- **INEXPENSIVE**
- **RECORDS ANY VARIABLE**
- **REPLACES METERS OR INDICATORS**
- **PANEL OR BULKHEAD MOUNTED**
- **BUILT-IN VARIABLE CHART SPEED**
- **JUST 3¾" x 3¾" x 3"**

Now you can take advantage of a new, economical means of recording any variable that can be converted to an electrical signal. Thanks to Omnicorder, you need no longer rely on meters or indicators, even where cost factors or space restrictions would ordinarily dictate the use of these instruments.

Measuring just 3¾" x 3¾" x 3", Edison's Omnicorder, a unique circular chart recorder, is so compact that nine units occupy just one square foot of space. Thoroughly legible, yet requiring no ink, pen or ribbon, Omnicorder is equipped with a simple three-speed adjustment which regulates chart rotation, thereby providing time sequences to meet varied needs. A flick of the switch gives users a choice of these sequences: one hour, seven hours and thirty hours per revolution — or one day, seven days and thirty days per revolution.

Omnicorder's simple, inexpensive construction assures dependable operation and a long, maintenance-free life. Four types of meter movements are available to measure a wide range of AC and DC electrical quantities, ranging from thermocouple outputs to currents as high as 100 amperes. No amplification is ever required, even for signals as low as 10 microamps.

For complete information on this rugged, maintenance-free Omnicorder, write for Catalog 3057.

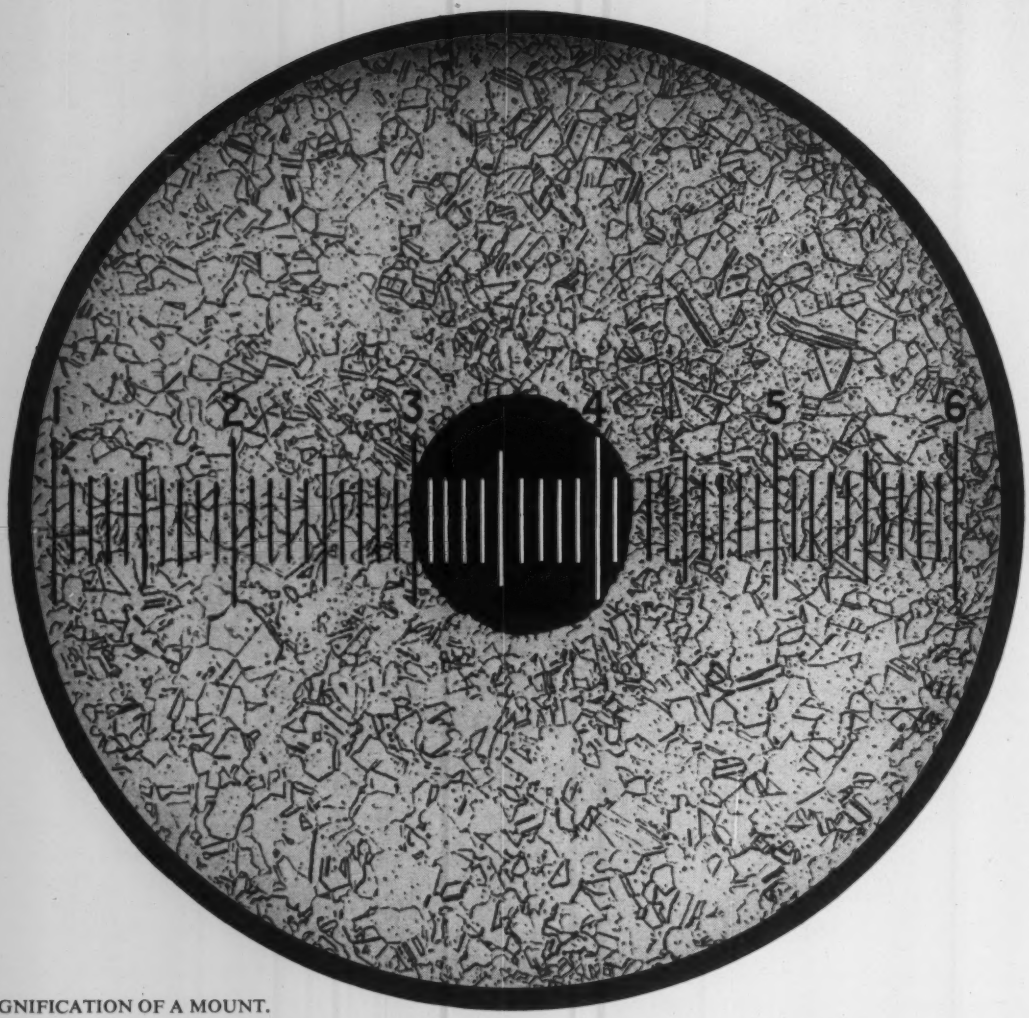


Stylus operates through this slot. The measuring system is sealed off from any careless tampering.

Zero Set Screw: Adjustment is made when measuring system is not printing and when the circuit to be recorded is disconnected.

Thomas A. Edison Industries
INSTRUMENT DIVISION
41 LAKESIDE AVENUE, WEST ORANGE, N. J.

CIRCLE 55 ON READER-SERVICE CARD



100X MAGNIFICATION OF A MOUNT.
Each division .001 in.

Capillary ID size is checked under 100x magnification

—yet this critical inspection is only 1 of 3 used to check ID of Superior capillary tubing

At Superior, in checking the ID size of capillary tubing we don't rely on only one reading from our inspection microscope, we require four. Then we double-check in two other ways—one the use of a relatively simple plug gage, the other a comprehensive flow inspection to ascertain the average ID dimension. These inspections also give you assurance of a free passage through the bore, uniformity of ID surface and a satisfactory grain structure.

Superior has spent years in the development of manufacturing processes and quality control procedures for the production of close tolerance capillary tubing. ODs range up to 3/16 in., IDs from .004 through .040 in. Analyses include Types 304, 316, 321, 347 and 446 stainless; also Monel, Inconel, nickel and carbon steel alloys. Data Memorandum No. 11 gives complete details—let us send you a copy. Superior Tube Company, 1968 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing
NORRISTOWN, PA.

All analyses .010 in. to 3/8 in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

CIRCLE 56 ON READER-SERVICE CARD

BUILD ECONOMY INTO YOUR SYSTEM, with American® Equipment!

If you're already using American measurement and control equipment on your system — large or small — you know how it reduces manpower requirements and provides continuous operating economies. If you're not already saving with American equipment, ask your representative for full information. You'll be surprised to learn how little it costs to build sustained accuracy, dependability and long-term operating economies into your system.

TELEMETERING SYSTEMS— Designed to meet the individual requirements of any system.

CONTROLLERS— Series A-88 Controllers, Transmitters and Receivers for measurement and control of continuous process variables.

ORIFICE METERS— Dri-flo and mercury manometers in recording, indicating and integrating models — in a variety of working pressures and differential ranges.

CANNON PENS— Record up to a year without refilling — produce charts of maximum legibility — no blurring or smearing.

RELIANCE REGULATORS— For industrial, commercial and house service applications.

AMERICAN METER CO. EST. 1836

AMERICAN® METER COMPANY

INCORPORATED (ESTABLISHED 1836)

GAS EQUIPMENT MANUFACTURERS GROUP GEM MEMBER

GENERAL SALES OFFICE: Philadelphia 16, Penna. • Albany • Alhambra • Atlanta • Baltimore • Birmingham • Boston • Chicago • Dallas • Denver • Erie • Houston • Kansas City Los Angeles • Minneapolis • New York • Omaha • Pittsburgh • San Francisco • Seattle • Tulsa • Wynnewood

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SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase, and Welded Steelcase Meters • American-Westcott Orifice Meters • Instruments • Reliance Regulators • Apparatus • Valves

CIRCLE 57 ON READER-SERVICE CARD

HENSOLDT
WETZLAR
WEST GERMANY

Noted for fine quality

SINCE 1852

Some of the many outstanding optical and precision measuring instruments made by Hensoldt:

OPTICAL DIVIDING HEAD

AUTOCOLLIMATING TELESCOPES
with mirrors and prisms

ALIGNMENT TELESCOPES
with illuminating stands or collimators

SCALE READING TELESCOPES

ZM SCALE READING DEVICE

KOMELUP MEASURING MAGNIFIER

CENTERING MICROSCOPE

OPTICAL UNIVERSAL BEVEL PROTRACTOR

MEASURING MICROSCOPE

MEASURING MAGNIFIER

"DIAMAL" STEREO MICROSCOPE

Write for literature on equipment in which you are interested.

CARL ZEISS, INC.

485 FIFTH AVENUE, NEW YORK 17

•

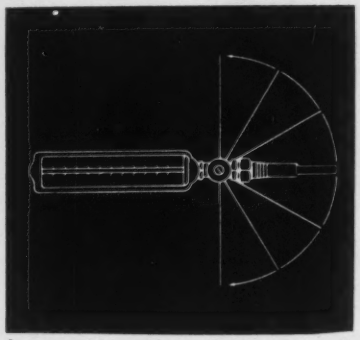
COMPLETE SERVICE FACILITIES

•

CIRCLE 58 ON READER-SERVICE CARD

Adjustable Angle Industrial Thermometer

The Moeller Adjustable Angle Industrial Thermometer (is) especially made to meet the demands of engineers and contractors for a rugged, dependable ther-



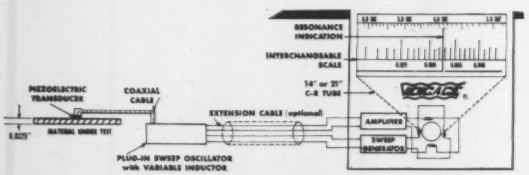
mometer that can be adjusted to any angle for any installation . . . the thermometer can be tilted or rotated to any angle to provide ease of scale reading and eliminate parallax error. A screw and nut adjustment positively locks the thermometer into the desired position either before or after installation . . .

Moeller separable sockets are designed to withstand extreme temperature and pressures, and can be left in the pipline or apparatus to keep the system closed when thermometers must be removed . . . (*From* 8-*page Catalog* 400, *Moeller Instrument Co.*, 132*nd St. & 89th Ave., Richmond Hill* 18, *N. Y.*)

FOR THIS LITERATURE CIRCLE 213 ON READER-SERVICE CARD

Ultrasonic Test Gage

The Vidigage Tester measures a wide range of thicknesses, detects laminar discontinuities and internal defects . . . non-destructively from one side of the work . . .



A piezoelectric transducer, excited by an electronic sweep oscillator, vibrates over the range of frequencies generated by the oscillator. When the transducer is placed in contact with one surface of the material under test, with a thin film of liquid as a coupler, continuous ultrasonic waves pass into and through the material and are reflected back from the first discontinuity they encounter, either an internal flaw or the opposite surface . . . When the continuously-varying frequencies of the ultrasonic waves equal the resonant frequency of the part, or are a multiple (harmonic) . . ., there will be a considerable increase in the amplitude of the vibrations in the material, . . . producing an increase in the plate current of the oscillator tube . . . (*From* 8-*page bulletin, Branson Instruments, Inc.*, 37 *Brown House Rd., Stamford, Conn.*)

FOR THIS LITERATURE CIRCLE 214 ON READER-SERVICE CARD

(*Continued on page* 1212)

YOUR BEST BUY FOR APPEARANCE AND PERFORMANCE... WESTON 301 PANEL METERS

Now... modern 3½-inch meters with time-tested Weston movements

You'll find new design advantages in the familiar, reliable Weston 301 panel instruments. Case and mechanism are redesigned for modern needs—more reliable than ever before—at no increase in cost!

The exclusive Cormag® mechanism makes the 301 immune to the effects of stray magnetic fields. Instruments can be mounted on magnetic or nonmagnetic panels, close to other instruments, *without* special adjustments. Choose between round or rectangular case, modernistically styled in phenolic plastic.

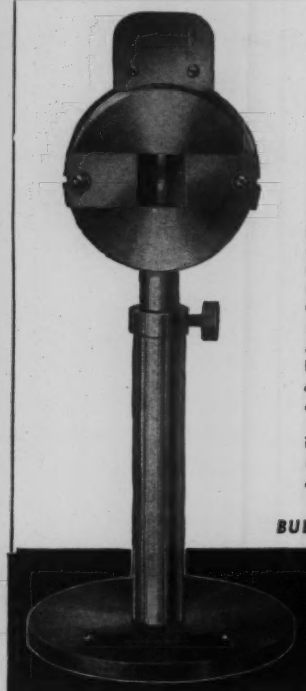
Another design advantage... New 2½-inch Weston panel instruments—the 201 series—are designed with matching cases and incorporate the same advanced features!

For specifications... information... or the address of your nearest distributor, contact your local Weston representative, or write to: Daystrom, Incorporated, Weston Instruments Division, Newark 12, New Jersey.
International Sales Division, 100 Empire Street, Newark 12, New Jersey. In Canada: Daystrom Ltd., 840 Caledonia Rd., Toronto 19, Ontario.

Weston 301 Series is available in ac, dc, and RF types . . . voltmeters, ammeters, milli- and micro-ammeters . . . in dozens of ranges. Both round and rectangular meters are flush mounted. 301 Series requires 2.82" diameter cutout. 201 Series requires a 2.22" cutout.

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION
Reliability by Design

CIRCLE 59 ON READER-SERVICE CARD



EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.

BULLETIN No. 3 ON REQUEST—Address: 2 Sheffield Ave., Newport, R. I.

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

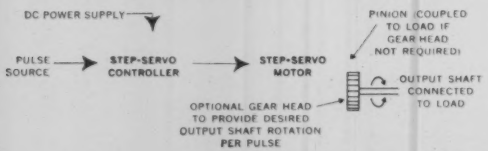
NEWPORT, RHODE ISLAND, U. S. A.

CIRCLE 60 ON READER-SERVICE CARD

Step-Servo Components

The reversible Step-Servo Motor differs from conventional AC servo motors in that it operates bi-directionally on DC voltages, switched by a logic

DIGITAL TO ANALOG CONVERSION


DC POWER SUPPLY
PULSE SOURCE
STEP-SERVO CONTROLLER
STEP-SERVO MOTOR
PINION (COUPLED TO LOAD IF GEAR HEAD NOT REQUIRED)
OUTPUT SHAFT CONNECTED TO LOAD
OPTIONAL GEAR HEAD TO PROVIDE DESIRED OUTPUT SHAFT ROTATION PER PULSE

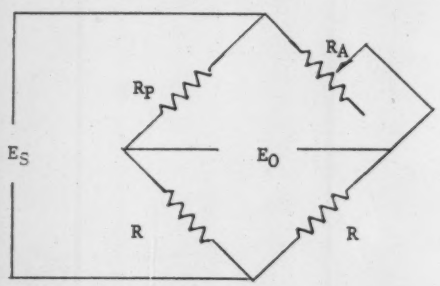
controller at a desired stepping rate. It can position a shaft or instrument accurately without need for expensive position pickoffs and complicated feedback mechanisms . . .

Intelligence in the form of pulses is fed into the ADC controller which, in turn, processes these pulses by means of transistorized switching logic so that the proper windings in the step-servo motor are energized, and the rotor is caused to rotate either clockwise or counter-clockwise exactly one step or increment per pulse . . . Characteristics vary with the motor selected, but typical motors will follow exactly pulse rates in the order of 0 to 120 pps, and can be slewed at rates exceeding 200 pps . . . (*From new 8-page bulletin, Automation Development Corp., 11824 W. Jefferson Blvd., Culver City, Calif.*)

FOR THIS LITERATURE CIRCLE 215 ON READER-SERVICE CARD

New Temperature Detector

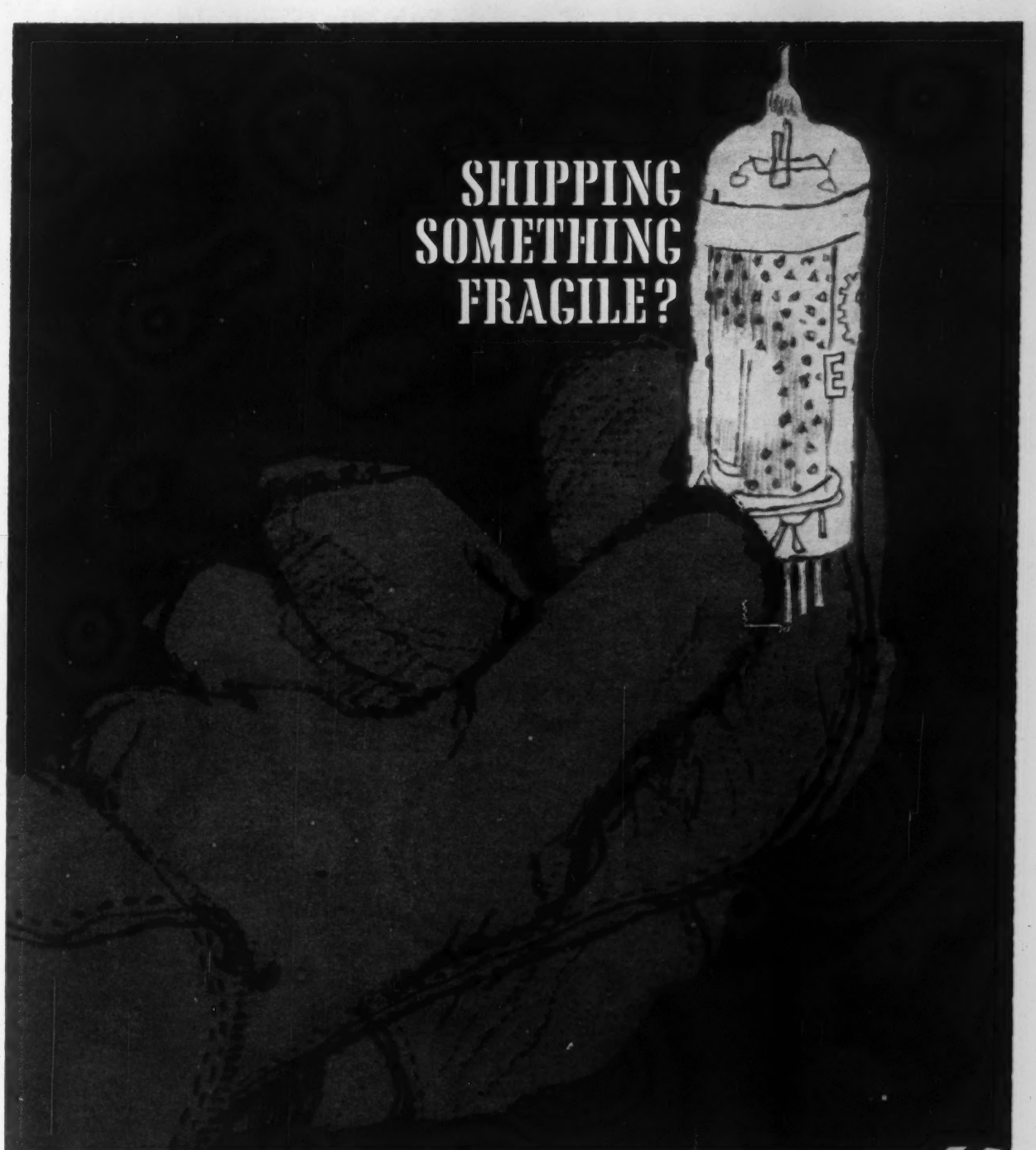
A new resistance Temperature Detector has been developed with resistance wires interwoven with fiberglass threads to provide a rugged, accurate, and inex-



pensive sensing element. CIC's Detector is classified as the ribbon-type with inherent design capability which provides greater resistance per linear inch, ability to fit curved or irregular surfaces with almost complete absence of strain gage effects . . . Woven design further provides excellent stability . . . Widths range from ½" to 3". Total length of the Detector, because of the physical construction, is never a limiting factor . . . CIC Temperature Detectors are manufactured with either platinum or nickel wire and are suitable for use up to 1,000°F . . . (*From News Release, Control Indicating Corp., Bradley Field, Windsor Locks, Conn.*)

FOR THIS LITERATURE CIRCLE 216 ON READER-SERVICE CARD

(*Continued on page* 1214)



CALL THE GENTLE MEN OF AIR CARGO *Tender treatment of delicate shipments is a KLM specialty. KLM has been flying cargo internationally longer than any other airline... over 42 years, in fact. And all the years of service have taught KLM people the best ways to deliver cargo in a hurry, at low cost... intact. Call your KLM Cargo Representative. He'll send your order to any overseas city. He'll make all the necessary decisions, accept complete responsibility, keep close watch over your shipment till it's delivered. He's the answer man of cargo— the biggest reason why KLM is cargo choice of the world. KLM Royal Dutch Airlines, 609 Fifth Ave., New York, N. Y.*

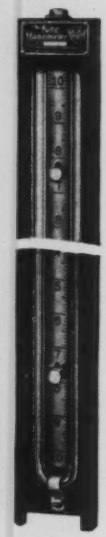
THE WORLD OVER
KLM
ROYAL DUTCH AIRLINES

CIRCLE 61 ON READER-SERVICE CARD

King MANOMETERS FOR PLANT AND LAB

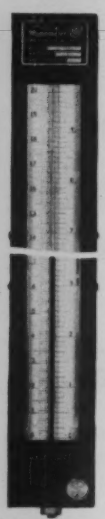
give UNFAILING ACCURACY at MINIMUM COST in measuring PRESSURE, VACUUM and FLOW

King Manometers are used throughout industry for measuring pressure, vacuum, differential pressure, and pressure-related phenomena. They operate as a liquid-filled U-tube (the *basic reference standard* for pressure measurement) - - have no mechanical moving parts. Their readings depend *solely* on the force of gravity, the specific gravity of the indicating liquid, and the pressures applied. Thus, they are unfailingly accurate - - and they permit exact duplication of operating conditions.



In addition, King Manometers are inexpensive, easy to install, cost nothing to operate, and require practically no maintenance.

TYPES and SIZES for EVERY SERVICE:

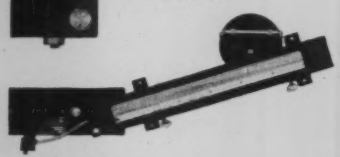


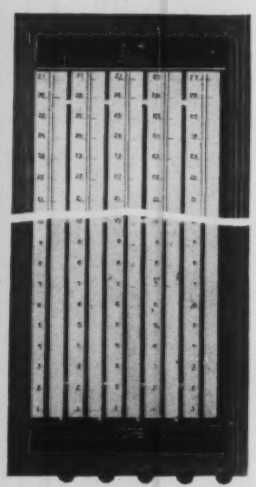
U-Type Manometers
Single cleanout (shown at right); double cleanout; with 3-valve manifold; inverted.

Well-Type Manometers
Low-well (shown at left); raised-well; adjustable-well; barometric; instrument test (8-scale); flowmeter.

Multi-Tube Manometers
With individual wells in fixed position; with common wells, fixed or adjustable; Photo-Manometers.

Inclined-Tube Manometers
General-utility (shown below); high-precision; draft gauges.





FEATURES Include—
• Wide choice of range (6" thru 130"), scales, liquids, mountings and materials. • Sturdy construction. • Easy cleanout. • Full line of accessories.

MANOMETER CATALOG 2008 explains basic principles; simplifies manometer selection; shows complete line of manometers, accessories and indicating liquids. Write for it.

KING ENGINEERING CORPORATION
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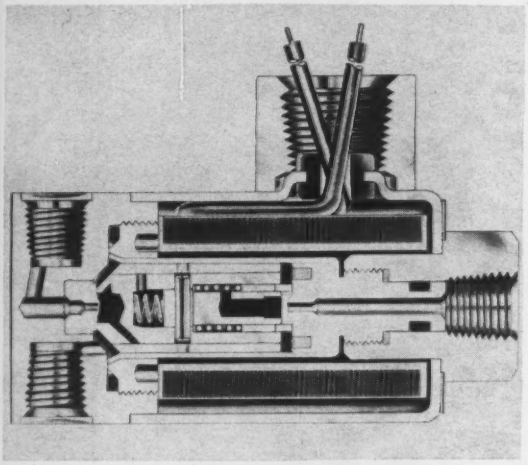
Sub-Min Solenoid Valves

New basic design is sub-miniature solenoid valves . . ., the B Series, (is) for use in hydraulic and pneumatic devices and control systems . . . smaller than any other standard line of valves presently available,

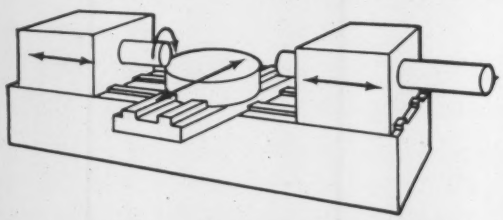


measuring only 1" in diameter x 2¼" high, and weighing 5 ounces . . . Three-way normally closed valves are now available from stock. Three-way normally open, directional control and two-way N.O. and N. C. valves will be available shortly . . . Coils in most a-c and d-c voltages and frequencies are standard. Housings are available with choice of grommet or ¼" NPT conduit for electrical connections . . . (*From new 2-page Press Release, Skinner Electric Valve Div., New Britain Conn.*)

FOR THIS LITERATURE CIRCLE 217 ON READER-SERVICE CARD

Numerical Positioning Controls for Machine Tools

Dimensional information is inserted in the input preparation unit in decimal form—the same language as that used on the drawing . . . A Tape Preparation

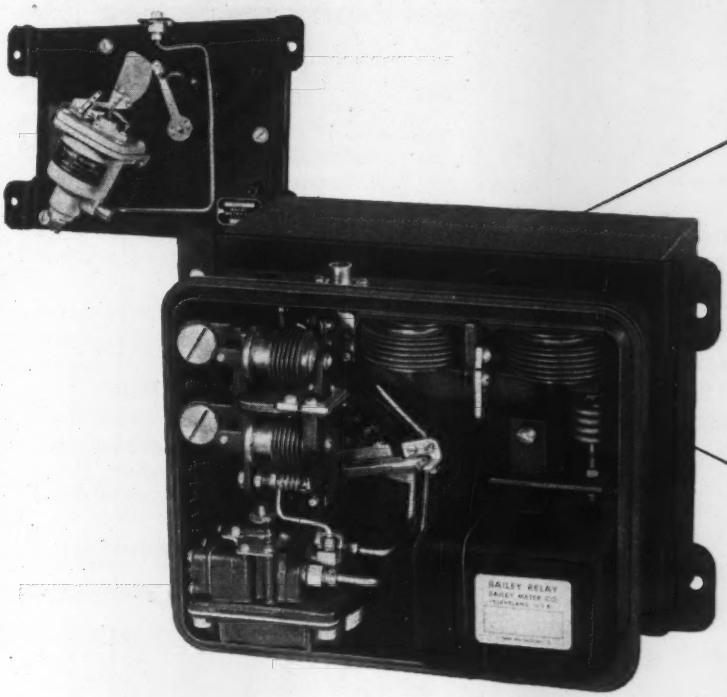


Unit is available with the controls—or a standard Flexowriter can be used . . . A Rheem photo-electric tape reader uses tape joined in a continuous loop to minimize handling . . . The control is of the on-off type capable of generating creep and stop signals to control the machine slides . . . Incremental feedback is from a single and rugged transducer geared to a ball-bearing lead screw fed to a bi-directional decimal summing register which also accepts input from the tape. Resolution available is very high . . . (*From new 8-page bulletin, Electronics Div., Rheem Mfg. Co., 5200 W. 104th St., Los Angeles 35, Calif.*)

FOR THIS LITERATURE CIRCLE 218 ON READER-SERVICE CARD

(*Continued on page* 1216)

Heart of your automatic control system...
the BAILEY COMPUTING RELAY



Performs these
COMPUTER FUNCTIONS

- MULTIPLIES • DIVIDES
- REVERSES • SUBTRACTS
- AVERAGES • TOTALIZES

pneumatic inputs

Gives these
CONTROL ACTIONS

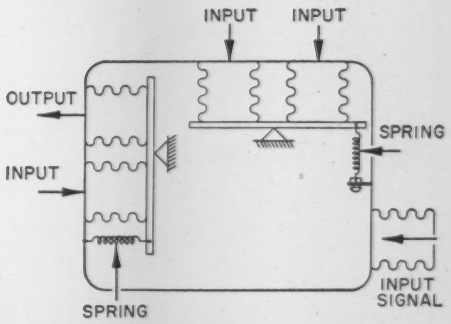
- PROPORTIONAL
- PROPORTIONAL plus RESET
- PROPORTIONAL plus RATE
- PROPORTIONAL plus RATE plus RESET
- FLOATING (reset only)

Here's quick, accurate, off-the-shelf help that can simplify automatic control-system design . . . provide almost any needed control and computing functions from multiple pneumatic input signals, flexibly and efficiently.

The Bailey Type AR80 Computing Relay is designed to receive pneumatic signals from transmitters, controllers and/or relays, and to produce an output signal which is determined by the computing and/or control functions provided in its system. It can be used singly to perform the functions indicated, or with additional units, for more complex functions.

It can also be supplied with provision for remote adjustment of proportional band. This is accomplished either with linkage drive between receiver bellows and proportional band adjustment to give linear action, or with cam drive to permit nonlinear as well as linear computations. Nozzle-vane mechanism is sensitive but sturdy—response is fast but low in air consumption. Signal ranges are standard 3-15 and 3-27 psig. Write for full specifications.

G-163-1



Multiple loading bellows gives wide flexibility By adjusting spring tensions and loading appropriate bellows, Bailey Computing Relay provides variety of functions, including: compensating flow from pressure or temperature; multiplying or dividing one signal by another; variable ratio adjustment for a different controller; adjustment of proportional band from remote manual or automatic source; introduction of nonlinear correction factor from a process stream analyzer; compensation of level measurement from specific gravity or temperature.

Instruments, controls, and systems

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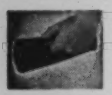
CAMBRIDGE Moisture Indicators

Cambridge Moisture Indicators are accurate, rugged instruments built for continuous shop service to indicate moisture content of various hygroscopic materials. Insertion model has measuring element enclosed in a blade. Surface model has the element mounted on under side for surface contact. Adjustable pointer is provided for fixing reference points of surrounding air.



Surface Model

Insertion Model

For use in Hat, Printing, Textile, Food industries and in processing Paper, Wool, Cotton, Rayon, Fur, Cereals, etc.

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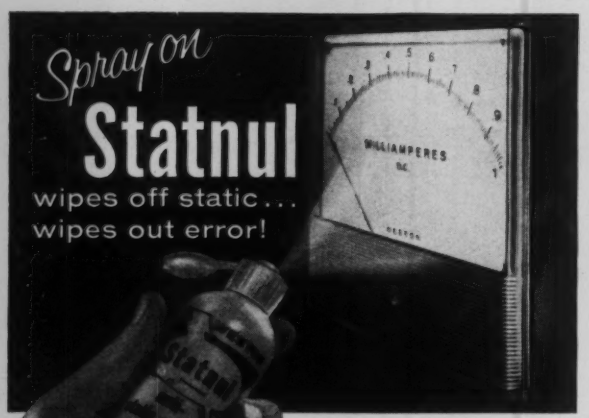

Static electricity can cause false readings in panel and test instruments . . . especially with plastic-faced meters. Eliminate this problem for months with new Weston STATNUL. *Spray or apply* with saturated cloth—then wipe. An invisible shield drains away static. *Cleans and polishes* with every application . . . wards off abrasive dust.

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flow requirements are imposed . . . The small size, high base resistance, and extreme ruggedness of these devices are achieved through Microdot's unique sensing element of platinum film deposited on a miniature ceramic disc. . .

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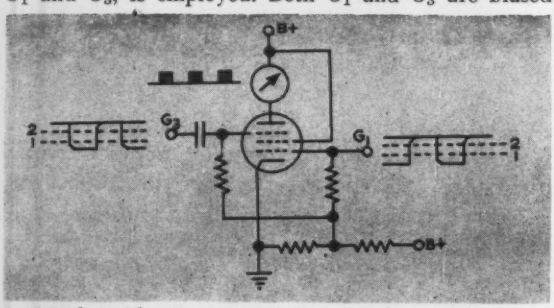
FOR THIS LITERATURE CIRCLE 219 ON READER-SERVICE CARD

Coincident Slicer

The figure shows a circuit diagram of a coincident slicer where a gated-beam tube with two control grids, G_1 and G_3, is employed. Both G_1 and G_3 are biased



positively with respect to their cathode, and both applied signals are negative. The plate current of the gated-beam tube cannot flow unless G_1 and G_3 are above their cutoff value simultaneously. When both input signals are at their most negative values, plate current cannot flow . . . Dotted line #1 and dotted line #2 represent the cutoff and saturation levels, respectively, of the gated-beam tube used in the coincident slicer . . . Since the irregularities of both input signals, such as rounded corners and overshoots, are outside the region of dotted lines #1 and #2, the plate current will not be affected by such irregularities. Another advantage of using a coincident slicer is that the output meter reading can be made virtually independent of the variations in output amplitudes of the cathode-coupled limiters, or supply voltages of the tubes . . . (*From 4-page bulletin, "Precision Phase Meters," Ad-Yu Electronics Lab, Inc., 249 Terhune Ave., Passaic, N. J.*)

FOR THIS LITERATURE CIRCLE 220 ON READER-SERVICE CARD

(*Continued on page* 1220)

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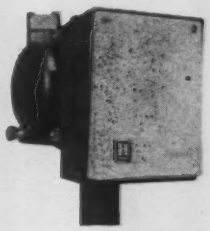
NEW BELLOWS FLOW TRANSMITTER

gives you field indication plus convenience and precision



You get all the economy and convenience of pneumatic transmission and all the efficiency of the bellows meter body plus field indication, when needed, in the new Honeywell Bellows Flow Transmitter. Use it in any application to transmit flow or liquid level measurements in open or closed tanks.

This new meter has automatic ambient temperature compensation and two-way overload protection for 100% of span. Maintenance is greatly simplified by modular construction which lets you remove any major component by loosening two screws. All field adjustments are easily accessible, and a self-locking feature prevents upset after calibration adjustments are made.

You can change ranges in the field simply by removing a single spring assembly and replacing it with an assembly of the desired range . . . adjust damping quickly and accurately, while the instrument is in operation . . . install the meter with either vertical or horizontal piping, so that it vents, drains and purges itself. The meter transmits with calibrated accuracy of ±0.5% of full scale, and indicates within ±1.0% of full scale.

For complete details on the new Bellows Flow Transmitter, call your nearby Honeywell field engineer. Or write MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.—In Canada, Honeywell Controls, Ltd., Toronto 17, Ontario.

New Bellows Transmitter is available with a concentric scale or as a non-indicator. It has 16 ranges—from 0-10 inches of water to 0-400 inches of water.

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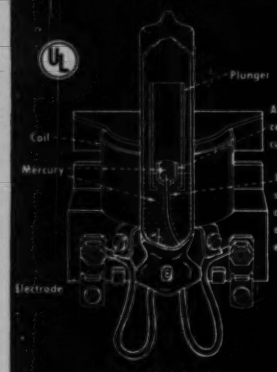

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Soaking pit tests at 2400°F prove THERMO-KANTHAL's outstanding reliability

A five-week test against costly platinum/ platinum-rhodium couples proved THERMO-KANTHAL's outstanding emf stability and long life. Deterioration was slight, even at this extreme temperature.

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KANTHAL

THE KANTHAL CORPORATION
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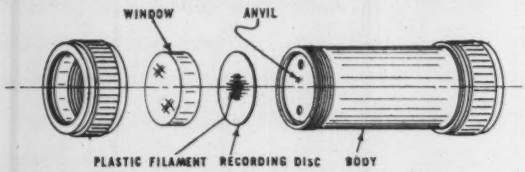
Canadian Rep., Ferro Enamels, Ont., Canada

CIRCLE 68 ON READER-SERVICE CARD

Shock Recorder

Model A12 shock recording accelerometer . . . utilizes a deformable plastic filament that is squeezed between an internal seismic mass and a glass window

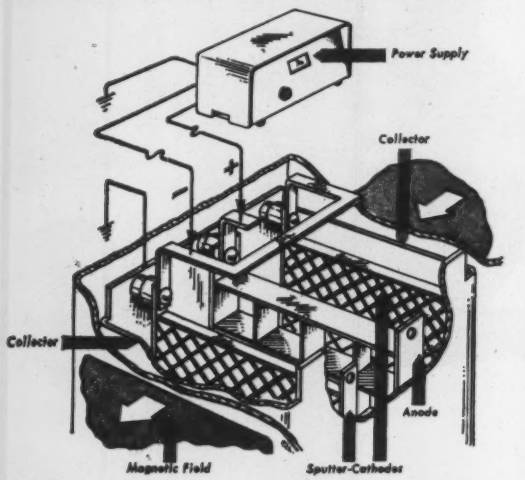


to indicate the magnitude of shock . . . Gives permanent record of maximum shock . . . Responds to short duration shocks . . . Records positive and negative acceleration . . . Recording method: Plastic filament crushed against direct reading scale on replaceable recording disc. The record is obtained by the squeezing effect of a spring mounted mass on one side and a heavy window on the other . . . A calibration scale is furnished with the recording discs . . . (*From new 2-page bulletin, Pace Engineering Co., 13035 Saticoy St., North Hollywood, Calif.*)

FOR THIS LITERATURE CIRCLE 221 ON READER-SERVICE CARD

Vacuum Ion Pumps

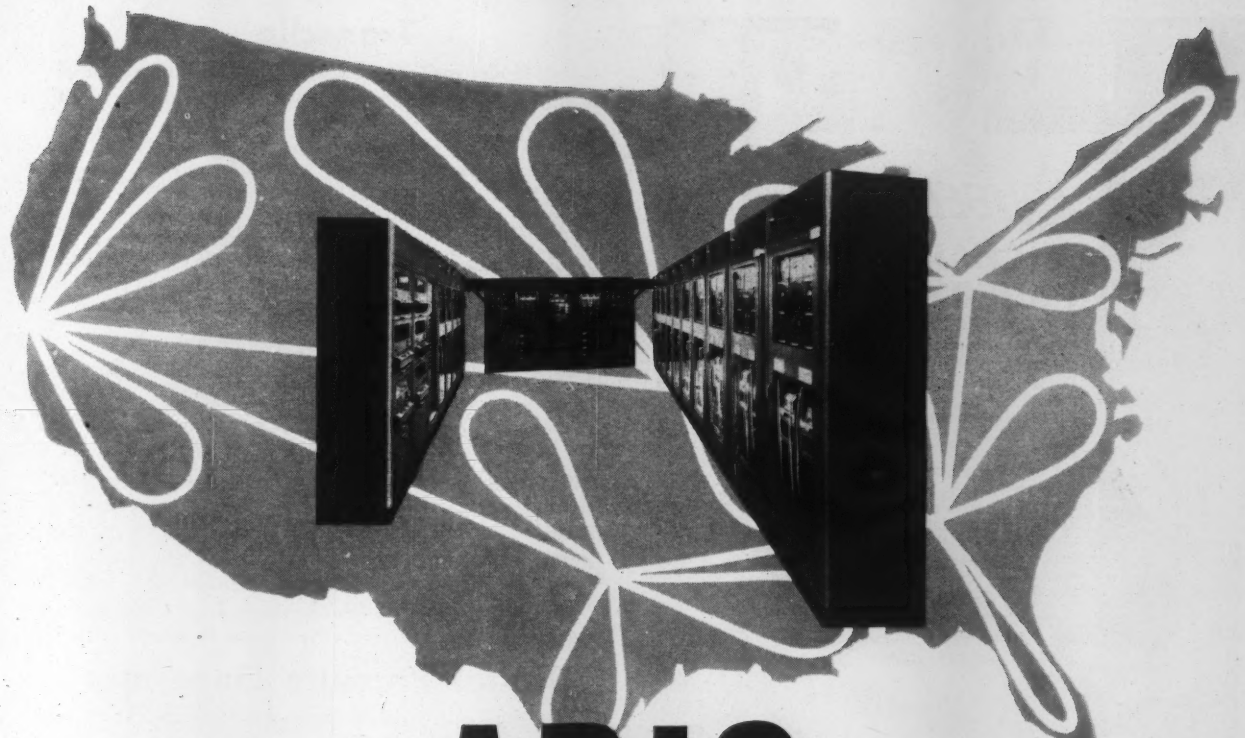
The DriVac pump is a compact, three-electrode, getter-ion pump suitable for such applications as semiconductor processing, deposition of thin films, etc.



Cutaway of DriVac pump illustrates advantages inherent in triode configuration. Positive ions, travelling away from the anode, sputter titanium from the sputter-cathode and deposit it on the grounded collector. Very few of the ions which pass through the cathode grid strike the collector with enough force to free any of the deposited titanium. A diode ion pump, on the other hand, utilizes a common electrode as both cathode and collector. This means sputtering titanium from the same surface on which the bases are being buried. As a result, ions striking the cathode discharge particles of titanium which had previously trapped ions against the surface, thereby-re-emitting pumped gases into the chamber . . . (*From 8-page Bulletin 6-2, Consolidated Vacuum Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.*)

FOR THIS LITERATURE CIRCLE 222 ON READER-SERVICE CARD

(*Continued on page* 1222)



ADIS

Communications breakthrough

New Teletype Automatic Data Interchange System (ADIS) now enables the Federal Aviation Agency to interchange aviation weather data coast-to-coast ten times faster than ever before.

With this new electronic message switching system, the FAA effects a major advance in the speed, scope and flexibility of its weather communication service—which supports all civil and extensive military aviation in the United States.

Nucleus of the system is a series of five Interchange Centers, located in Kansas City, Cleveland, Atlanta, Fort Worth and San Francisco. Each of these acts as a clearing house for a number of area circuits, or outlying "loops," collecting data from observation points on these loops and providing the area circuits with data from other parts of the country.

Teletype electronic communications equipment at the Interchange Centers carries out an automatic program of sequentially calling data-originating stations, classifying messages by priority, selecting only those weather items wanted at regional stations, and delivering them to the area circuits—while maintaining the ability to handle emergency traffic when required.

Ultra-fast communication between Interchange Centers is provided by Teletype punched tape equipment operating at 850 words per minute, utilizing the DataPhone concept. Stations on outlying loops are equipped with Teletype Model 28 page printer and punched tape units. Speed-conversion equipment permits automatic interoperation between the national circuit and the local loops. Thus the new system, which serves some 2,400 locations, can report weather conditions from any part of the country in a matter of minutes.

The FAA, through the years, has followed a program of continually upgrading its facilities to meet the needs of the nation's growing air traffic. Teletype Corporation is proud of its part in providing communications equipment for this vital service.

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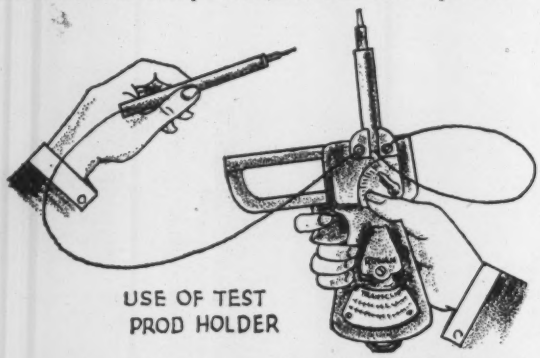
Cambridge 39, Mass. Tel. Eliot 4-2989

CIRCLE 70 ON READER-SERVICE CARD

Transclip

The Model 400 Transclip is an AC voltmeter and ammeter with a clip-on transformer than opens to fit

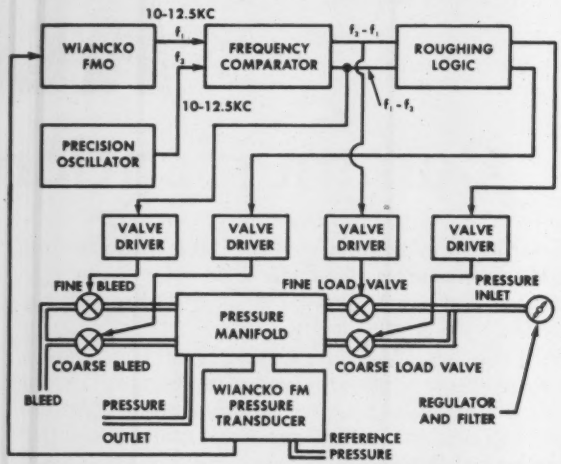


over cables or bus bars . . . The pistol design permits the operator to open the jaws of the transformer by pressing the trigger, select the range scale with the thumb and manipulate the unit, all with one hand . . . (*From new* 12-*page "Special Test Equipment" catalog, Rowan Controller Co., Red Bank, N. J.*)

FOR THIS LITERATURE CIRCLE 223 ON READER-SERVICE CARD

Digital Pressure Generator

The digital frequency comparator is the heart of this system, and it is fed the outputs from the precision oscillator and the frequency modulated oscillator. It then answers the simple question as to which of the



two frequency inputs is greater. If the frequency from the pressure sensor is high with respect to the reference oscillator, the comparator produces a difference frequency in the form of pulses. These pulses then drive bleed valves until the pressure drops to the preselected value. When the frequency is low, error signals are produced which operate pressurizing valves until the pressure rises to the preselected value. A response time of fifteen seconds has been achieved by incorporating a two-stage load and bleed valve system, coarse controls to provide rapid initial response, and fine controls to complete bringing the system into balance . . . (*From* 44-*page System Engineer's Handbook, Wiancko Engineering Co.,* 255 *N. Halstead, Pasadena, Calif.*)

FOR THIS LITERATURE CIRCLE 224 ON READER-SERVICE CARD

(*Continued on page* 1226)

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No oil filters.
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No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

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Not "just another" electronic miniature line . . . but the most advanced design for process control

Evaluate it yourself, against *your* control requirements. You'll quickly find that M-Line is the one miniature electronic control that's significantly different.

Based not only on L&N's direct experience in designing and building more than 70,000 electronic controllers, but incorporating as well many of the ideas suggested by instrument specialists in the process industries, this advanced instrumentation offers you a unique combination of advantages:

WIDEST SCOPE OF COMPATIBILITY IN OPERATION Can be used with virtually any commercially available primary element transmitter which produces a d-c current or voltage signal; can be integrated with data-handling or computing equipment;

SIMPLEST FUNCTIONAL DESIGN . . . Operation is uncomplicated, quickly understood by operators;

UNMATCHED INTERCHANGEABILITY OF COMPONENTS M-Line display and/or control units of varying sophistication can be readily substituted (simply plugged into the basic stations) even after installation and start-up;

OUTSTANDING FLEXIBILITY IN OPERATION AND IN APPLICATION . . . By-pass of signal to "end-operator" permits process operation even when various control system components are removed. Additionally, standard M-Line components form building-blocks for control systems of varying complexity.

Check the features listed . . . just a few of the engineering details that make M-Line an exceptionally sound and economical investment. Your local L&N representative has the full story . . . or for more detailed information write to Leeds & Northrup Co., 4955 Stenton Ave., Philadelphia 44.

LEEDS & NORTHRUP CO

FOR M-LINE CONTROLLER, CIRCLE 71 ON READER-SERVICE CARD

M-LINE CONTROL STATION

Unitized construction—only 6″ x 6″ front-of-panel space required for complete one- or two-pen recorder and controller, including set-point unit, auto-manual unit, and control unit.

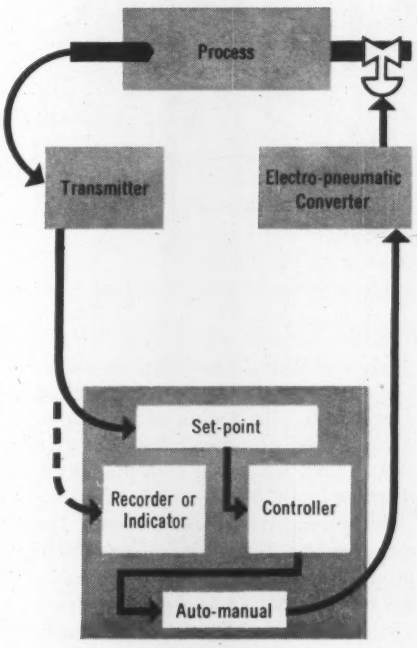
Simple auto-manual circuit design guarantees "bumpless" transfer from manual to auto, whether "on" or "off" control point—no balancing required. Easy to read—set-point index and measuring index use same calibrated scale.

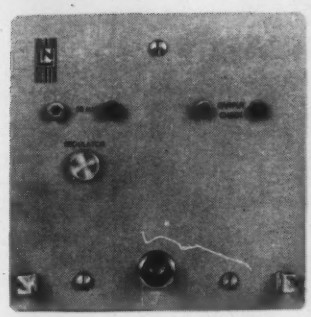
Controller transistorized, with high-impedance Nuvistor input stage—circuitry proved by years of industrial experience. Deviation from set-point will produce rate action, but due to circuit design, no rate upset is introduced when changing the set-point itself.

Control function adjustments in rear, to prevent tampering by unauthorized personnel.

Forward- or reverse-acting control achieved by switches, protected by foolproof locking plates; auto-manual station operation always the same, regardless of direction of control.

Available with 2- or 3-mode controllers. Proportional Band: 0–300%, continuous. Reset: Adjustable from 0.2 to 1000 repeats per minute for 2-mode controllers, 18 well-spaced steps; 0–100 repeats per minute for 3-mode controllers, 18 well-spaced steps. Rate: 0–8 minutes, continuous.





M-LINE TC/EMF TRANSMITTER

Measures any 0–5 to 0–60 mv d-c signal span from −60 to +60 mv.

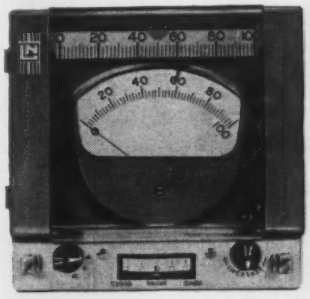
Transistorized circuits; Zener-diode reference.

All TC/EMF amplifiers interchangeable, regardless of application.

Range, reference junction compensation, and zero suppression resistors mounted on easily-changed card on terminal board.

Noise-free output signal with standard ranges of 1–5 ma or 0–4 ma into 500 to 2500-ohm load.

Input and output completely isolated—avoids grounding problems.



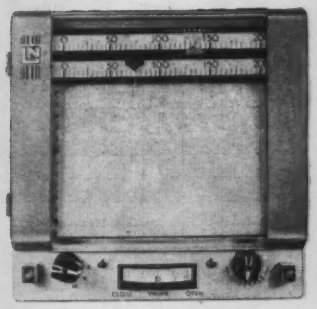
M-LINE INDICATORS

Available as one- or two-point indicators.

Clear, 3″ scale-length with continuous indication.

Easy to install and service; completely interchangeable with recorder—same case, same plug-in attachments.

LEEDS & NORTHRUP
Pioneers in Precision



SPEEDOMAX M RECORDERS

Available as one- or two-pen recorder with amplifiers completely encased.

4″ vertically-driven chart with continuous line record.

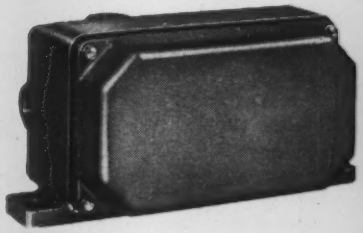
Potentiometric measurements of 4 v d-c (0–4 ma or 1–5 ma) using high-torque servo mechanism with optional retransmitting slidewires and high and low alarm contacts.

Recorder completely independent of the control circuit.

Recorder amplifier circuitry on printed cards for simplicity.

Sturdy 6″ x 6″ x 23″ case and rugged mounting—withstands rough handling and supports unusual loads.

Available with mercury-bottle disconnects for use in Class 1, Group D, Division 2, and many other safety features.



M-LINE ELECTRO-PNEUMATIC CONVERTER

Mounts in any position, in any location.

Resistant to vibration.

Weather-proof.

Maximum safety: uses minute energizing current, provides continuous air-purge of fumes.

Pressure output can be locked-up, in event of power failure.

Can be used with any controller having a 1 to 5 ma d-c current output.

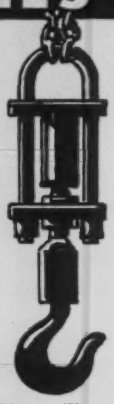
FOR TRANSMITTER, CIRCLE 72 ON READER-SERVICE CARD
FOR INDICATORS, CIRCLE 73 ON READER-SERVICE CARD

FOR RECORDERS, CIRCLE 74 ON READER-SERVICE CARD
FOR CONVERTER, CIRCLE 75 ON READER-SERVICE CARD

WEIGH ELECTRONICALLY

Ametron®
CRANE SCALES

Designed for fast —easy installation Visual or Printed Weights



Recorder may be mounted in crane cab or in other convenient locations. Prints tape or cards. Available at low costs in 5, 10 and 15 capacities. Rugged construction decreases maintenance.

Write for Brochure B-18

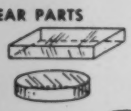
WRITE TO:

STREETER-AMET COMPANY
GRAYSLAKE, ILLINOIS
U.S.A.

CIRCLE 76 ON READER-SERVICE CARD

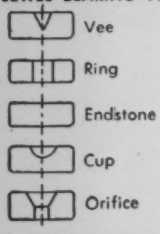
SAPPHIRE

WEAR PARTS



ELECTRICAL INSULATORS

JEWEL BEARING TYPES



Jewel Bearings - Wear Parts

If you need a surface finish polished to 1 RMS and/or a material of extreme hardness, high dielectric strength, resistance to heat and corrosion, SAPPHIRE could be the answer to your problem.

We design and furnish jewel bearing assemblies, controlled within critical tolerances, for direct installation in your product.

Ask for our 28-page Design Data and Applications Manual No. 5A on Jewel Bearings and other Precision Sapphire Products.

AURELE M GATTI INC.

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532 Tindall Ave.
Trenton, N. J.

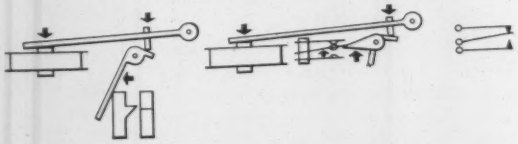
WEST COAST REPRESENTATIVE: Harold R. Swanton, Inc.
Los Angeles • San Francisco • Seattle

NEW YORK OFFICE: Charles Kastner, Inc., 580 Fifth Avenue

CIRCLE 77 ON READER-SERVICE CARD

Reset Timer

New line of Acrotimer reset timers provides delay or interval timing, opening or closing one or more switches after an adjustable period of time. Acrotimer adds two new features which must be explained . . .



(1) an electrically-actuated clutch outside the motor and (2) relay switches built into the timer.

A spring clutch is used in Acrotimer which is actuated by a coil and linkage assembly built into the timer. When the coil is energized, a mechanical motion takes place (illustration on l.h.).

Relay switches . . . are built into the timer and actuated by the same linkage mechanism as the clutch (illustrated on r.h.).

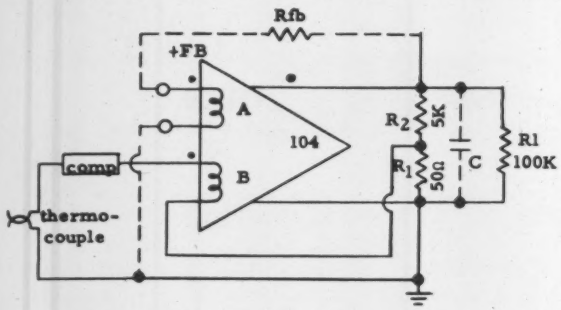
In addition to relay switches, the customer has his choice of one or two motor switches. Therefore, if maximum switching is used, it is possible to provide seven terminals for timed load control . . . (*From new 70-page basic timing instruction manual, "The Man on Time," Haydon Div. of General Time Corp., Torrington, Conn.*)

FOR THIS LITERATURE CIRCLE 225 ON READER-SERVICE CARD

Magnetic Preamplifier

Example 1, Thermocouple Amplifier (shown)

Assume an input signal of 0-20 millivolts from a thermocouple and its cold junction compensator. We desire a large input resistance, a gain of 100 times



to obtain 0-2 volts of output, and good accuracy. The load is 100KΩ.

The total load on an Acrostat should not have a resistance of less than 5000Ω. By inspection, we set R_2 to 5000Ω. This gives us a feedback ratio very close to the 100:1 ratio needed to give a gain of 100 times. We assume the external load of 100KΩ does not give a significant amount of load compared with the 5000Ω rated load. The effective input Z is found by dividing the signal input voltage by the input current. The Model 104 Acrostat requires 2μa of input current to give 2 volts of output. Hence, the input Z is 20 millivolts divided by 2μa or 10,000Ω . . . (*From 6-page Bulletin 10-C, Acromag, Inc., 22515 Telegraph Rd., Southfield, Mich.*)

FOR THIS LITERATURE CIRCLE 226 ON READER-SERVICE CARD

(*Continued on page* 1228)

accuracy

ASHCROFT DURAGAUGES measure pressure with precise accuracy no matter how severe the conditions of service

Ashcroft Duragauges are available in pressure ranges from 15 psi (or vacuum) minimum to 100,000 psi. Dial sizes: 4½" through 12".

sustained

The Bourdon tube in Ashcroft Duragauges is manufactured to precision standards of flexibility and mono-linked to the rotary movement. When pressure flexes the tube, the gauge pointer is always positively positioned, because it is mounted on the geared center shaft of the movement. Sustained high accuracy and long life are assured.

Choose your Ashcroft Duragauges made of components best suited to your needs. Eight Bourdon tube materials are available. Movement of stainless steel with nylon bearings and pinion gear for longest wear. Case materials: special aluminum alloy or tough phenol plastic.

The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

ASHCROFT PRESSURE GAUGES

A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
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CIRCLE 78 ON READER-SERVICE CARD

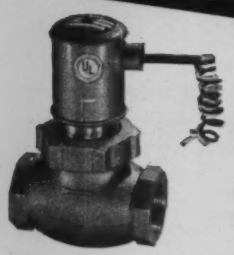
PHILADELPHIA
THERMAL CONTROLS AND THERMOMETERS

Specify!
THE BEST!
A half century of experience is back of every instrument we make. You get assured accuracy and long dependable performance when you specify "Philadelphia." Our specialized staff will be glad to discuss your problem in our field.
SEND FOR CATALOG 110
Since 1905

PHILADELPHIA THERMOMETER CO.
4401 N. Sixth St. • Philadelphia 40, Pa.

CIRCLE 79 ON READER-SERVICE CARD

Now . . . 7 Sizes of Gould
Solenoid Valves
bear this seal



They're Types Q and Q-1 in all these sizes:
⅜" • ½" • ¾" • 1" • 1¼" • 1½" • 2"

Fully Automatic • Normally Closed • Packless
2-Way • Piston-Pilot Operated • Bronze Body

TYPE Q General purpose for air and water at pressures from 5 to 400 psi; temperatures to 250° F. . . . and steam at pressures to 15 psi; temperatures to 250° F.

TYPE Q-1 For steam at pressures from 5 to 150 psi, and temperatures to 365° F.

Coils of both types are guaranteed unconditionally for a full year

Write for FREE Bulletin on Our Full Line of Solenoid Valves!

TYPICAL USER NET PRICES • F.O.B. FACTORY

SIZE	TYPE Q		TYPE Q-1	
	1 to 5	100 to 499	1 to 5	100 to 499
⅜" or ½"	22.00	19.25	29.10	25.46
¾"	26.00	22.75	33.10	28.96
1"	35.00	30.63	42.10	36.84
1¼"	43.00	37.63	50.10	43.48
1½"	66.00	57.75	73.10	63.96
2"	84.00	73.50	91.10	79.71

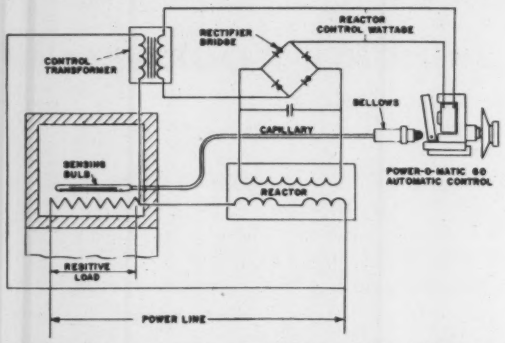
J. D. GOULD CO. • 4707 MASSACHUSETTS AVE. • INDIANAPOLIS 18, IND.

GOULD SOLENOID VALVES — VELVETROL

CIRCLE 80 ON READER-SERVICE CARD

Saturable Power Reactor Control

Temperature control systems utilizing Saturable Power Reactors are becoming a widely accepted, ideal

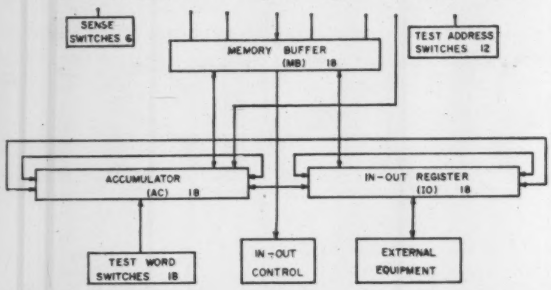


means for heat control . . . The complete absence of relays, switches, tubes, thermocouples and photo cells means that nothing is being expended in the process of maintaining a set temperature . . . (*From new* 240-*page General Catalog* 161, *on ovens, furnaces, humidity chambers, etc. Blue M Electric Co.,* 138*th* & *Chatham St., Blue Island, Ill.*)

FOR THIS LITERATURE CIRCLE 227 ON READER-SERVICE CARD

Programmed Data Processor

The Programmed Data Processor (PDP-1) is a high speed, solid state digital computer designed to operate with several types of input-output devices, with no



internal machine changes. It is a single address, single instruction, stored program computer with powerful program features. Five-megacycle circuits, a magnetic core memory, and fully parallel processing make possible a computation rate of 100,000 additions per second (about 2.5 times the speed of most large computers in use today, and more than 100 times the speed of magnetic drum computers) . . .

The powerful program features of PDP-1 include multiple step indirect addressing, Boolean operations, twelve variations of arithmetic and logical shifting, and ten conditional instructions. Six independent flip-flops, called "program flags," are available for use as program switches or special in-out synchronizers. Two special instructions, Multiply Step and Divide Step, are included in the Instruction List. Multiply and divide subroutines using these instructions operate in about 350 and 600 microseconds respectively . . . (*From* 32-*page booklet, Digital Equipment Corp., Maynard, Mass.*)

FOR THIS LITERATURE CIRCLE 228 ON READER-SERVICE CARD

(*Continued on page* 1232)

OKOFLEX® Armored Instrument Tubing saves you money three ways

For prompt quote on Okoflex Instrument Tubing, contact the nearest Okoflex representatives listed below.

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DIckens 4-2688

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CApitol 5-6059

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EXpress 7-5535

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H. G. Klug Company, Inc.
P. O. Box 1752, Benson Sta.
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EVergreen 2-6520

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58 St. Clair Ave.
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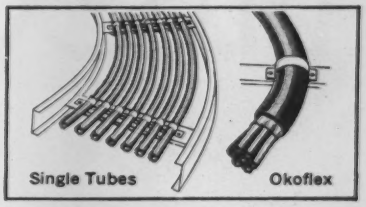
1 FASTER INSTALLATION



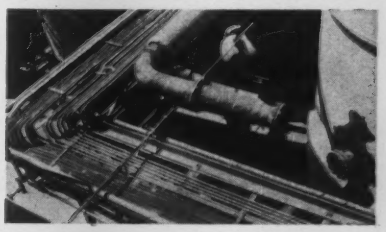
An Okoflex assembly consists of several tubes, already cabled together, which are installed simultaneously, instead of one at a time. Existing structures can be used for support, standard fittings for attachment. Armored Okoflex can be "fished" through hazardous locations without fear of tube damage. In addition, Okoflex is completely salvageable and can be taken down and used again.

2 EXTRA-LONG LIFE

Okoflex is the first construction to include a Mylar* tape over its core of tubes. This DuPont polyester film provides *extra* protection against both environmental corrosion and galvanic action between the tubes and a metallic covering. The Okoflex armor protects the tubes from physical damage, assuring longer life.

*Registered Trademark of E. I. du Pont de Nemours & Co. (Inc.)

3 ELIMINATES TUBE FLATTENING



Okoflex cable tubes—spiraled like strands of rope—can be bent on a small radius without distortion or flattening. And on delivery, you'll find *every* tube is usable . . . none bent or damaged. *In metallic types, a telephone line is included at no extra cost to provide for sound-powered phone communication.*

For engineering information and prices, contact your Okoflex distributor. Or write for Bulletin IC-1112 "Okoflex Armored Instrument Tubing."

THE OKONITE COMPANY
Subsidiary of Kennecott Copper Corporation
Passaic, New Jersey

8162

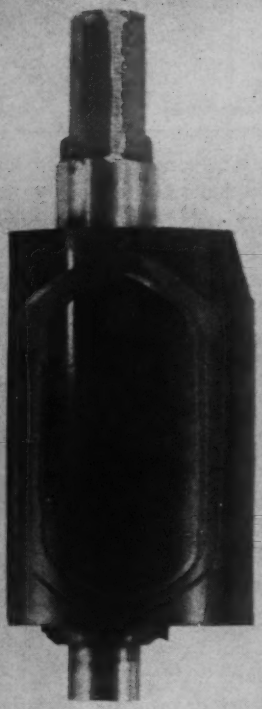
OKOFLEX...the low cost way to install instrument tubing

CIRCLE 81 ON READER-SERVICE CARD

PROOF!

2,000,000 Drip-tight Cycles

A REGULAR PERFORMANCE OF DeZURIK ECCENTRIC-ACTION CONTROL VALVES!



The unretouched photograph above is of a plug removed from a DeZURIK ECCENTRIC-ACTION VALVE after 1,400,000 cycles on water! The valve remained absolutely drip-tight; the resilient-compound plug-facing shows no rupture or erosion, there is no plug distortion. This plug indicates continual usefulness through thousands of drip-tight cycles!

On test after test—on actual job after job—DeZurik Eccentric-Action Control Valves have demonstrated phenomenal cycle life! Extended service through two million cycles is nothing unusual for these valves. And throughout that long service, they deliver dead-tight shut-off, operate with the utmost accuracy and ease, require no lubrication and virtually no maintenance!

DeZurik's unique ECCENTRIC PRINCIPLE is the key to the remarkable performance of DeZurik Valves. An eccentric or cam-shaped plug is matched to an eccentrically-raised seat. Contact between them is made only when the valve is closed; the slightest rotation in the quarter-turn cycle lifts the plug from the seat and the action is free, easy, friction-free. No seizing, no sticking.

Flow is straight-thru without restriction; throttling is attainable with exceptional accuracy and to virtually any curve desired. Flow characteristics can be changed easily by changing a cam in the positioner without dismantling the valve.

DeZURIK CONTROL VALVES have highest rangeability plus the versatility in size, body metals and plug materials, operators and controls, to custom-fit any flow-control situations. They will PROVE to you that the Eccentric-Action Valve CONTROLS BEST...and with amazingly longer cycle life!

WRITE FOR BULLETIN 150

DeZURIK CORPORATION
SARTELL, MINNESOTA

CIRCLE 82 ON READER-SERVICE CARD

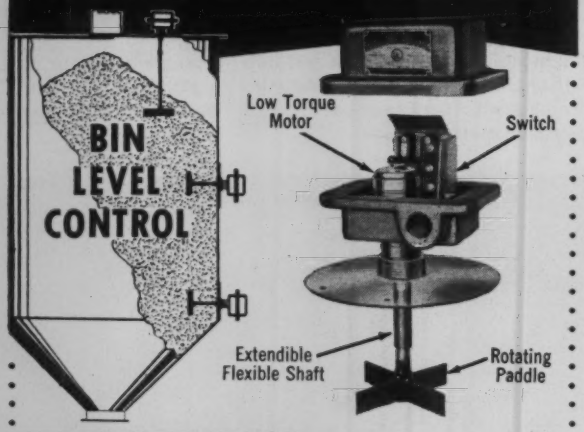
Reliability a Reality With Bourns Transducers

In program after program... firing after firing... Bourns transducers are surviving the most brutal environmental punishment ever inflicted on sensitive instruments. Their ability to provide precise indication of position, pressure or acceleration under any conditions has contributed to the success of the most important missile and aircraft programs of our time. For engineering that combines design skill with success... promise with performance... contact Bourns, the pioneer in precision transducers.

Pioneers in transducers for position, pressure and acceleration. Exclusive manufacturers of Trimpot®, Trimit® and E-Z-Trim®.

CIRCLE 83 ON READER-SERVICE CARD

ROTO-BIN-DICATOR



HIGH IN PERFORMANCE -All Models Heavy Duty
LOW IN COST -Most Popular Model $55.00
FIRST IN SALES -Since 1957

Underwriters' Laboratories Listed
General Purpose and Explosion-proof Models

Product of
THE BIN-DICATOR CO.
17190-B4 Denver, Detroit 24, Mich.

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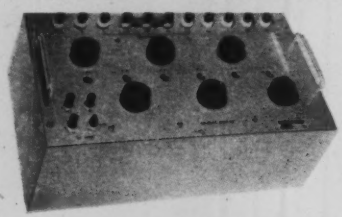
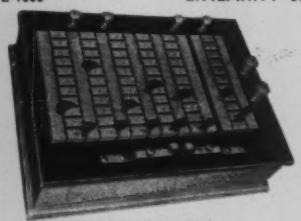
CIRCLE 84 ON READER-SERVICE CARD

PRECISION INSTRUMENTS FOR
STANDARDIZING LABORATORIES

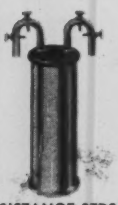


E-3002 SIX DIAL UNIVERSAL RATIO SET
LIMIT OR ERROR ± (0.001% + 0.001 ohm)
LINEARITY 0.0001%

E-1000



ANTHONY PATTERN
WHEATSTONE BRIDGE



RESISTANCE STDS.
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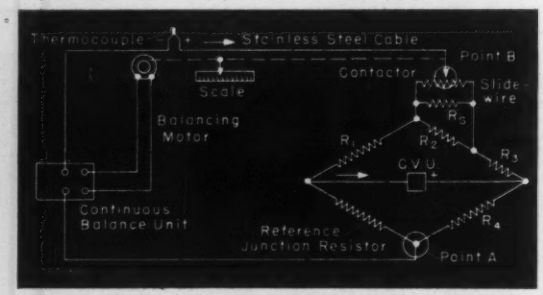
CIRCLE 85 ON READER-SERVICE CARD

Potentiometers, Bridges

The sensitivity, sustained accuracy, and reproducibility of ElectroniK instruments results from the use of the null-balance principle for measurement. The amplifier detects any circuit unbalance and automatically maintains the system at the null point.



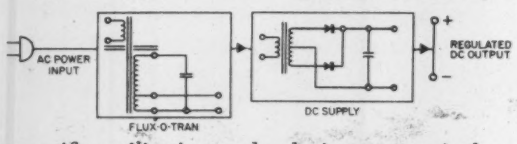
The *potentiometer circuit* (illustrated) is used with thermocouples, Radiamatic units and other voltage-producing primary elements. This voltage is measured against the slidewire voltage at point B. Any difference between the two voltages, between point A and B, is amplified and energizes the balancing motor to move the slidewire contractor B until the difference in voltage is reduced to zero. The Zener diode constant voltage unit (C.V.U.) operates from line voltage input and delivers a constant and continuous standard voltage to the measuring circuit. The dry cell, standard cell, and other parts usually associated with standardization are eliminated. The reference junction resistor automatically compensates for variations in thermocouple reference junction temperature.

The Wheatstone *bridge* circuit is used primarily with resistance thermometers. The thermometer element is connected in a bridge arrangement having three calibrated resistance elements and a slidewire. If the bridge is not in balance, the balancing motor is actuated to drive the slidewire contactor—and associated indicating, recording, and control mechanisms—until the bridge is balanced . . . (*From new* 48-*page Catalog* C15-1*a, Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Phila.* 44, *Pa.*)

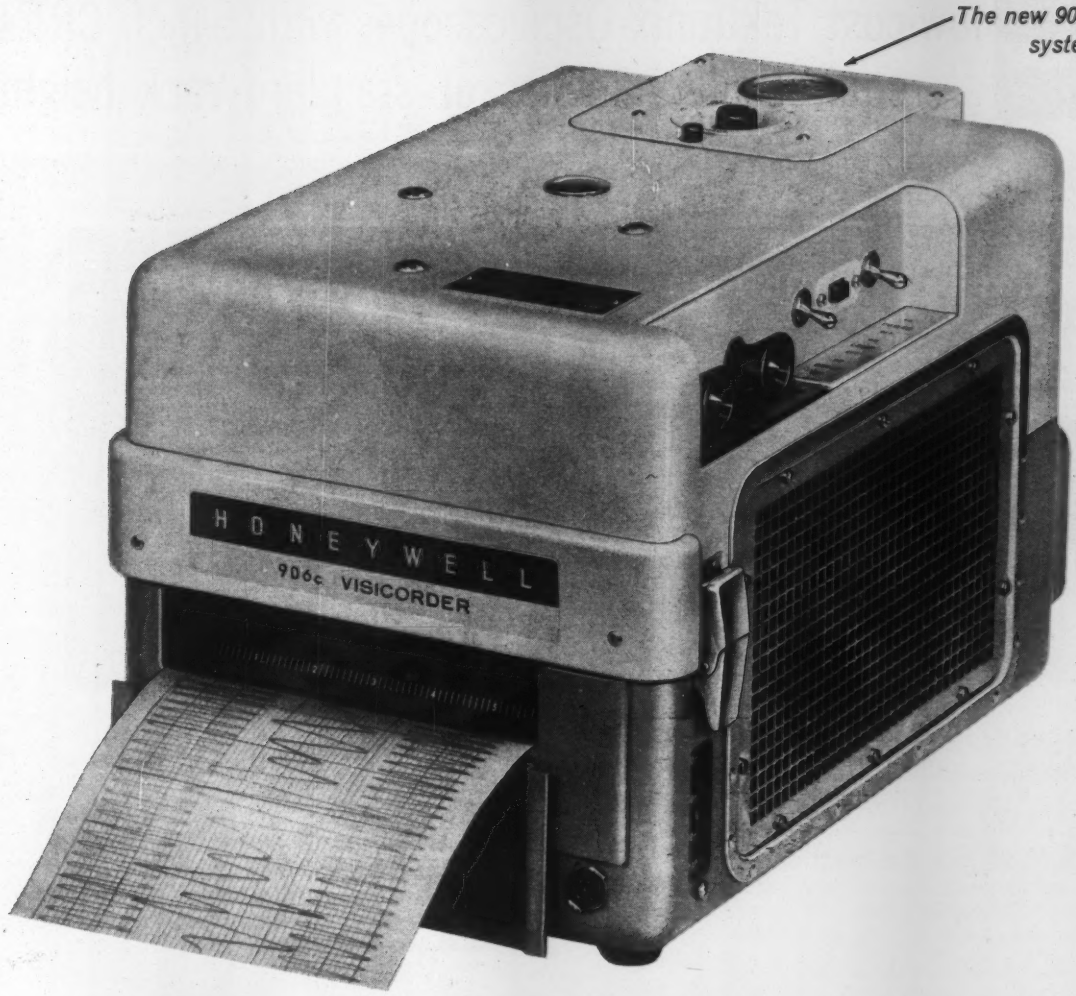
FOR THIS LITERATURE CIRCLE 229 ON READER-SERVICE CARD

Voltage-regulated Supplies

"Flux-O-Tran" constant voltage transformer delivers regulated squarewave voltage to rectifier, improving rectifier utilization, and reducing output ripple . . . Continuously variable voltage control permits output settings from 0 to maximum rating . . . Transformer and DC overload circuit breaker allow output to be shorted without damage to unit. Ideal for lighting lamps and charging capacitive loads . . . Power efficiency typically 70-80% . . . Reliable, efficient, full-wave rectification . . . (*From new* 32-*page Catalog B*-611, *Kepco, Inc.*, 131-38 *Sanford Ave., Flushing* 52, *N. Y.*)



FOR THIS LITERATURE CIRCLE 230 ON READER-SERVICE CARD



What's *different* about the NEW 906C VISICORDER OSCILLOGRAPH?

At first glance you may see no difference at all. Just the same functional lines and compact size that you have come to recognize in the Visicorder.

They have not changed since 1956, when the Visicorder principle of oscillography made immediate readout of high frequency data possible for the first time.

Until now, all the improvements that have maintained the Visicorder's record of leadership have been internal:

—increased capacity to 14 channels
—higher frequency response (0-5000 cps)
—simultaneously recorded grid lines
—self-starting lamp for remote operation

But the 906C has a new feature you *can* see, (look carefully at the back of the case) and one that represents still another breakthrough; a built-in flash tube timing system which not only generates its own time base, but which can also be triggered *externally*. You can, in other words, use the 906C's timing system to record time lines simultaneously with data. Or you can trigger the timing circuit externally—either by supplying a pulsing voltage of only +10v into 20K ohms impedance, or simply by causing impedance to drop to 100 ohms or less through shorting-out or other means.

Thus your "time" signal may actually be an event marker related to shaft rotation, belt movement, or any other effect which might be more conveniently fed to the timing circuit than to a galvanometer.

(Owners of Visicorders 906, 906A, and 906B will be glad to know that only a *field-change* is necessary to economically and easily add this timing system to their instruments).

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CIRCLE 86 ON READER-SERVICE CARD

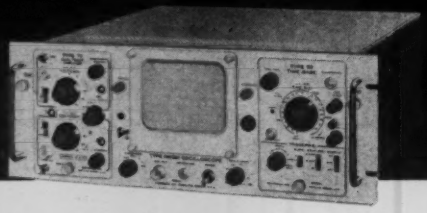
now low-cost Tektronix Oscilloscopes with 5-inch CRT's ...require only 7 inches of standard rack height

Tektronix Type RM561

A new, rack-mount, laboratory oscilloscope—basically an Indicator which accepts a wide range of plug-in units in both channels—the Type RM561 offers the type and degree of performance demanded for particular applications in the dc-to-4 mc region.

Indicator Unit ..... f.o.b. factory **$450.00**

(without plug-in units—which range from $50 for a basic amplifier to $250 for the versatile dual-trace unit.)



Besides the 5-inch rectangular crt, other features of the Indicator Unit include: 3.5 KV accelerating potential, 8 cm by 10 cm viewing area, Z-axis input, 6 calibrated square-wave voltages from 1 mv to 100 volts (available at the front panel), regulated dc heater voltage thru separate regulator circuitry, regulated dc supply—which operates between 105 to 125 volts or 210 to 250 volts, 50-60 cycles to provide 85 watts of power for the plug-in units.

The plug-in units drive the crt deflection plates directly, house approximately ⅔ of the circuitry, contain minimum components and controls.

Eight plug-in units are presently available. These include two time-base units—one with 21 calibrated sweep rates from 1 μsec/cm to 5 sec/cm, 5X magnifier, extremely adaptable triggering facilities, external input to sweep amplifier, 1 v/cm sensitivity—and also six signal-amplifier units. The signal-amplifier units range from basic units (with passband from dc to 400 kc at maximum sensitivity, sensitivity approximately 1 v/cm with attenuation provided by variable potentiometer at the input) to more complex units including those for differential-input, dual-trace, and wide-band applications.

In addition, plug-in units under development include those for pulse-sampling, four-trace work, high-gain measurements, strain-gage and other transducer applications.

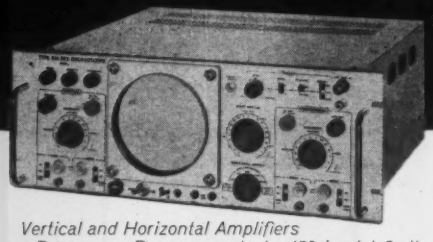
You can even design your own circuitry into skeleton units available.

Tektronix Type RM503

A new, complete-unit, rack-mount oscilloscope, the Type RM503 features practically identical horizontal and vertical amplifiers, 21 calibrated sweeps, five degrees of sweep magnification, extremely adaptable triggering facilities.

A differential-input X-Y Oscilloscope, the Type RM503 ideally suits curve-plotting applications using the X-Y method of operation, as well as most other laboratory applications in the dc-to-450 kc region.

Type RM503 ..... f.o.b. factory **$640**



Vertical and Horizontal Amplifiers

Frequency Response—dc to 450 kc (at 3 db down).

Sensitivity—1 mv/cm to 20 v/cm in 14 calibrated steps, variable uncalibrated from 1 mv/cm to 50 v/cm.

Differential input and constant input impedance at all attenuator settings.

Sweep Range and Magnification

Linear Sweeps—1 μsec/cm to 5 sec/cm in 21 calibrated rates, variable uncalibrated from 1 μsec/cm to 12 sec/cm.

Sweep Magnification—2, 5, 10, 20, or 50 times.

Triggering Facilities

Fully automatic, recurrent, or amplitude-level selection on rising or falling slope of signal, with AC or DC coupling, internal, external, or line.

Tektronix Cathode-Ray Tube

5-inch crt at 3KV accelerating potential provides bright trace on 8 cm by 10 cm viewing area.

Amplitude Calibrator

500 mv and 5 mv peak-to-peak square-wave voltages available.

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All critical dc voltages—and the input-stage heaters of both amplifiers—are electronically regulated.

For a demonstration of either of these versatile low-cost rack-mount oscilloscopes, please call your Tektronix Field Engineer.

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CIRCLE 87 ON READER-SERVICE CARD

Trends in Photoprocessing

GEORGE T. EATON

Eastman Kodak Co.

THE BASES of photographic processing were Talbot's discovery of development in 1839 and the use of hypo in 1839 as a fixing agent. It was soon observed that the fixing bath chemicals had to be removed from processed negatives and prints if the image was to be preserved. Therefore, from the beginning, investigations were initiated to study the control of development, fixation, and washing to provide quality and permanency of negatives and prints.

For many years glass plates, paper negatives, and prints were hand-processed. Then roll films were introduced, eventually with directions for tray processing, and then tank processing in blankets or aprons and on reels.

Within a relatively few short years mechanization was accomplished in several fields, for example, automatic rack and tank processing of x-ray sheet films and amateur roll films, and the continuous processing of 16- and 35-mm motion-picture films. Probably the most extensive studies were made in the design of continuous processing equipment and the chemical control required to provide uniformity of development and complete processing for permanent motion-picture film records.

The ability to view images more quickly in oscillograph recording was indicated years ago. In many technician and scientific applications of photography today, one important requirement is "an immediate look at the image." Even in radiography in hospitals and elsewhere it is important to reduce the time between exposure and viewing of the radiograph. To summarize these requirements, today it is desired:

1. To provide the processed film or paper as quickly and as conveniently as possible.

2. To provide an image for viewing sometimes even before the processing is completed—immediate image access.

3. To provide precision processing and take control out of the hands of the machine operator.

4. To provide adequate image quality for specific applications.

What has occurred so far? A few examples will suffice:

1. Office photocopies are made in about a minute by the image transfer processes (based on chemical diffusion) and by the Kodak Verifax Process (based on physical transfer).

2. The Diebold Microfilm Processor permits in-office processing in less than one hour of 100' rolls of film in office-type equipment.

3. The CEC Datarite Processor yields developed images of recorded traces at 125 feet per minute with an access time of 0.8 second.

4. The Rapatronic camera-processor-projector presents the film images for convenient viewing in less than 5 seconds.

5. The X-Omat Processor and others produce dry, completely processed radiographs in 6½ minutes instead of one hour or more.

6. The Land Polaroid process yields a snapshot in 10 seconds.

7. The Kelvin-Hughes Processor provides a large projected reversal image every 30 seconds.

8. After seventy years, monobath processing appears to be practical for some specific appreciations.

There are other processes that should not be overlooked which do not require chemical processing in the usual sense, but which do provide useful images rapidly—the electrostatic processes like Xerography, the thermographic processes like Thermofax, the organic systems like diazo and Kalvar and print-out materials like Linagraph Direct Print Paper or Lino-Writ 5.

With the advent of new scientific, industrial, and business applications it became apparent that "complete" processing for permanent records was not always necessary. Indeed, immediate access to the image is often more important in many applications than a permanent record, especially if it can be obtained in small, compact, convenient, and automatic equipment.

Photographic and electronic data recording and processing systems are in part competitive and in part complementary at present. Photographic systems are being improved to remove such disadvantages as delayed access time and high labor cost. Photographic systems have the following advantages:

1. Pictures highest in information potential.
2. Visible image for fast qualitative read-out.
3. High resolution.
4. Exceptionally high accuracy.
5. Known record permanence and stability.
6. Information content can be increased by color.
7. Reliability.

Abstract from address presented before Society of Photographic Scientists and Engineers.

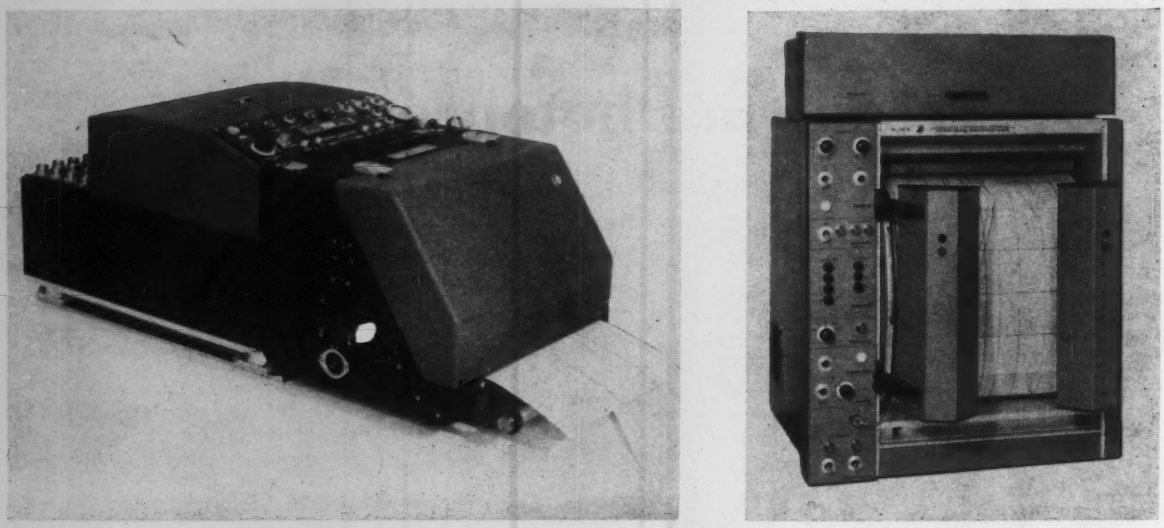


FIG. 1. DEVELOP-OUT system (left) uses processing by chemical; print-out system (right) uses processing by light. Recording oscillograph at left is Model 5-119 with 5-036C Datarite magazine; right is 5-123 with Dataflash rapid latensification facility.

Rapid-Access Oscillograph Recording

J. H. JACOBS, Bell & Howell Research Center

RAPID-ACCESS PHOTOGRAPHY is a term used to describe photographic methods which give access to recorded information or to a picture in a period of time significantly shorter than that required for its production by conventional processing techniques. Examples: The "peel-apart" office copy method, by which photocopies may be made in about one minute; the Polaroid Land process now gives a snapshot in 10 seconds; the Rapatronic camera-processor-projector gives a projected film image in less than 5 seconds.

In oscillograph recording, a pen or light beam can be used. The advantages of a light beam are (1) higher frequency response and (2) traces can overlap without interfering with each other, thus providing more channels on a given width of paper.

There are many light-sensitive materials, ranging from the slow diazo process through various processes of intermediate speed to the fast silver-halide systems. Some of the slow processes will give an immediate image, but they are not fast enough for recording in the kilocycle range. The only materials applicable to such high-speed recording are the *silver halides.*

Silver-halide photosensitive materials come in two types: *Develop-out* and *print-out.* Develop-out materials require the application of a developing solution to make the "latent" image visible (as in a snapshot camera). *Rapid-processing* of the develop-out photosensitive material now can give rapid access to the image—but where a completely dry process is desired, or where the paper must run at a speed above that of chemical processing units (approx. 25 ips), then *print-out paper* is preferred.

A *print-out* material gives an immediate image in an oscillograph if the recording beam is moving comparatively slowly; at higher writing speeds only a "latent image" is recorded (as in develop-out materials) but the paper can be "latensified" by exposing it to the room light for about a minute. This makes the trace visible.

This article describes both a develop-out system with rapid processing (Datarite*) and a print-out system with flash latensification (Dataflash*).

Based on material presented by the author at the Rapid Processing Symposium of the Society of Photographic Scientists and Engineers, Washington, D. C.

*Regd. Trade name, Consolidated Electrodynamics Corp.

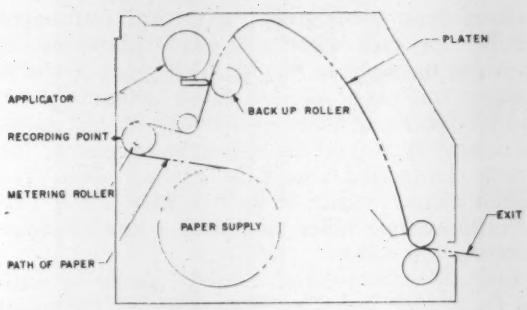


FIG. 2. DEVELOP-OUT system with rapid processing magazine (Datarite).

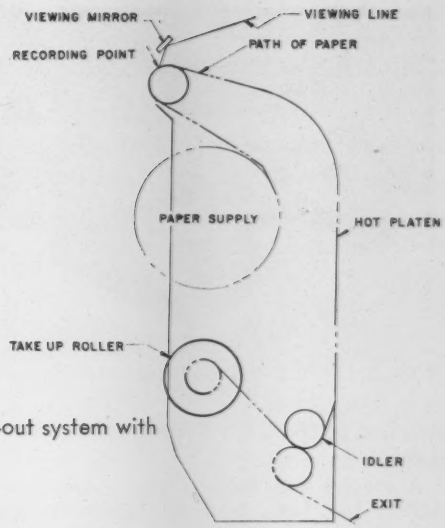


FIG. 4. PAPER PATH through print-out system with rapid latensification (Dataflash).

Rapid access to photographic or oscillographic records can be achieved by use of (1) develop-out paper with rapid chemical processing, or (2) print-out paper with rapid latensification. Both systems are described.

Develop-Out System with Rapid Processing (Datarite)

The Datarite system uses develop-out recording paper. Many varieties of this paper are available, some of which are now specifically adapted to the Datarite process. The processing is done during the recording operation, in the magazine which holds the supply of paper.

A thin layer of a special developer is spread on the emulsion side of the paper immediately after it is exposed. The paper then is run with its back in contact with a hot platen which is normally at about 120°C. The heat accelerates development and then dries the paper. The resulting record is stable indefinitely, but if diazo copies of the record are desired, a subsequent treatment with hypo, which may be done in daylight, will improve contrast.

Several embodiments of the Datarite process are available. The paper path of the first type to be built (CEC Type 5-036) is shown in Fig. 2. The length from the recording to the exit rollers is 20". Hence, at a paper speed of 25 ips, the access time is 0.8 second. Curve 1 of Fig. 3 shows the access times obtainable at paper speeds between 0.1 and 25 ips, which are the operating limits of this instrument.

For speeds up to 10 ips, a cover with a red window can be used to replace the standard solid cover over the platen. This permits one to view the paper over most of the platen length and reduces the access distance from 20 to 11 inches. Curve 2 of Fig. 3 shows the access times obtainable in this way over the speed range 0.1 to 10 ips. This instrument handles 12"-wide paper and is normally

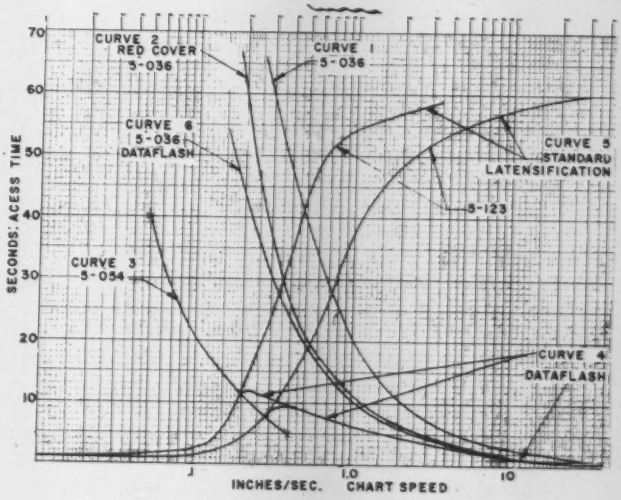


FIG. 3. ACCESS TIME versus chart speed for various develop-out (Datarite) and print-out (Dataflash) systems. In develop-out systems (curves 1, 2, 3) access time is simply time for paper to reach the exit. Hence the faster the chart speed, the less the access time. Curves 5 are for print-out paper. At low chart speeds the beam produces an image immediately and can be seen by mirror; at higher chart speeds, up to 1 minute is required for latensification. Dataflash (curves 4) reduces the latensification time. Curve 6 shows result of using the Datarite magazine with a Dataflash rapid latensification cover, as shown in Fig. 5.

FIG. 5. TYPE 5-119 oscillograph with 5-036 Datarite magazine and Dataflash cover.

attached to the CEC Type 5-119 recording oscillograph.

A special *slow-speed Datarite* Instrument (Type 5-054) has been built for airborne applications. By using only one roller and a shoe for backing up the solution applicator and for exposure, and because a short platen can be used at low paper speeds, it has been possible to reduce the access distance to 2". Curve 3 of Fig. 3 gives the access times over the range of available operating speeds, which is 0.05 to 0.4 ips (3 to 24 ipm).

Progress has been made in improving the quality and the stability of the record. Manufacturers of sensitive materials have cooperated by making available both papers and developers which produce a record which appears little different from one processed conventionally.

Print-Out System with Rapid Latensification

Records can be made on print-out paper using a super-high-pressure mercury-vapor lamp, but there is no direct print-out effect at writing speeds above a few inches per second. At the higher writing speeds the record has to be "latensified"—that is, exposed to ambient room lighting for about 1 minute in order to bring up the trace. Writing speeds of 75,000 ips or more can be obtained in this way.

However, the proper utilization of these higher writing speeds demands a relatively high paper transport speed, and this at once leads to another difficulty. If an oscillograph is producing a record at the rate of 2 feet per second, for example, and all of this record has to be exposed to the room lighting for one minute, then, if the test lasts for more than just a few seconds, a considerable footage of paper has to be exposed to the room lighting. Hence the 1-minute latensification time not only delays access to the recorded data but also can lead to an awkward paper-handling problem.

Access to records on print-out paper now can be obtained in from 1 to a few seconds by a technique known as *Dataflash*. When printout paper is heated to about 70°C and above, it can be latensified rapidly with high-intensity ultraviolet, blue or green fluorescent light. Examples of instruments embodying this process are the 5-123 and —124.

Fig. 4 shows the paper path through the 5-123 print-out-type oscillograph, a vertical instrument suitable for rack mounting. (This instrument is shown at the right in Fig. 1.) The paper is visible within a fraction of an inch of the recording point, and the recording beam can be seen by the operator where it strikes the paper by means of the mirror shown just above the writing roller. The heated platen extends from a position about 1½" from the writing roller to a point a short distance from the exit rollers.

Latensification is carried out by means of vertical fluorescent lamps on either side of the paper path, shining directly on the paper as it travels vertically downwards over the platen. The access times available from this configuration, both with and without Dataflash operation, are given in Fig. 3 by curves 4 and 5 respectively.

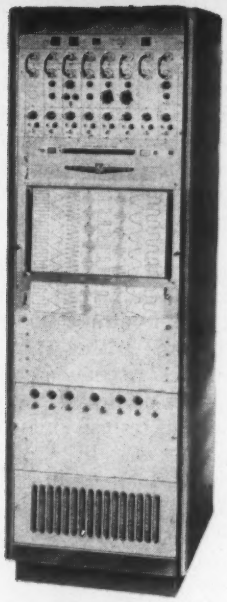
The two curves (5) show the rapid print-out at low writing speeds, which can be seen by the mirror beam-monitor feature. At higher writing speeds, however, the full 1-minute standard latensification is required.

The time which a high-speed trace takes to become visible depends to some extent on the instantaneous writing speed. For this reason a single curve which will apply to all situations cannot be given. Instead, two typical curves near the extremes of the writing speed range have been shown. Curves (4) and (5) part company at a point where direct print-out ceases to be a factor. Beyond this, curve (5) rises to the 1-minute latensification time, whereas curve (4) reflects the influence of chart speed on access time—that is, the faster the speed the less the time for the paper to reach the exit and the Dataflash lamps.

Actual latensification takes place in one second once the heated record reaches the vicinity of the lamps. Beyond about 16 ips, the chart is out of range before latensification is complete, and so the curve is shown rising again. However, up to 40 ips, which is the limit for Dataflash operation, the latensification process is given a sufficient start that the image is visible by the time the chart can be picked up and examined.

The Type 5-124 oscillograph recorder is a small 18-channel instrument using 7"-wide print-out paper in which the recording point is visible from the operating position. The Dataflash facility is not standard equipment on this instrument, but is available as an accessory. The access-time characteristics (both with and without Dataflash) are similar to those of the Type 5-123 oscillograph (with and without Dataflash).

An accessory for the Datarite magazine processor enables those already having the mercury-lamp version of the Type 5-119 oscillograph to use the Dataflash method (Fig. 6.) This is simply a cover for the Datarite which contains five 8-watt fluorescent lamps and which replaces the regular Datarite cover. Access time varies approximately inversely as the paper speeds up to the operating limit of 25 ips. This curve is shown as No. 6 in Fig. 3, and reflects the access distance of 10" plus an extra second for the latensification process.



NOMENCLATURE FOR DIRECT-WRITING RECORDERS

FRED C. ZUSI
American Optical Company

CHART SPEED INSTABILITY—The maximum instantaneous variation in chart speed which occurs with a fixed setting of the speed-determining mechanism; measured with respect to the long-term average chart speed immediately preceding or following the observed variation. (Slow gradual changes in chart speed may be called "chart speed drift.") Expressed as a percentage of the average chart speed.

CHART-SPEED RESPONSE TIME—The time required for the instantaneous chart speed to approach the desired average chart speed, within a given small percentage, immediately following a programmed change in chart speed . . . Generally applied to changes in speed from one finite speed to another, rather than from zero to some speed (starting) or from some speed to zero (stopping). Usually measured as the time required to approach to within 5% of the new speed. (Alternatively, the chart-speed response **Time Constant** may be used. This measures the time required to achieve 63% of the desired change in chart speed, and is related to the electrical time constant. In overdamped systems, it may be misleading.)

CHART WOBBLE—The peak instantaneous deviation which occurs in the chart motion of the direction parallel to the recording axis (perpendicular to the desired direction of chart motion) during any one (or any combination) of four modes of operation: starting, stopping, changing speed, or steady running. Usually observed by (mechanically) fixing the position of the writing mechanism and observing the trace position as the above-listed chart speed modes are established. (Slow, gradual deviations may be called chart position drift.) Expressed in millimeters.

Abstract from Eng. Bulletin 101, American Optical Co., Instrument Div. Correspondence on this nomenclature is invited.

SENSITIVITY—The instantaneous ratio of deflection to the magnitude of the input signal. Ideally, a constant for perfectly linear recording of highest accuracy.

BASE-LINE INSTABILITY (ISOTHERMAL)—The peak instantaneous variation in the zero-signal trace, under isothermal conditions, with rated line voltage and frequency variations. Slow, gradual variations may be called "base-line drift." Expressed in millimeters, usually ± around the nominal base-line zero position.

BASE-LINE INSTABILITY (THERMAL)—The peak variation in the zero-signal trace under constant line voltage and frequency conditions, with rated ambient temperature variations. Expressed in millimeters, usually ± around the nominal base-line position.

SENSITIVITY INSTABILITY (ISOTHERMAL)——The peak instantaneous variation in the sensitivity, with constant input signal amplitude, under isothermal conditions, with rated line voltage and frequency variations. Expressed in percent of nominal sensitivity, usually ± around the nominal value. Slow, gradual variations may be called "sensitivity drift."

SENSITIVITY INSTABILITY (THERMAL)—The peak variation in the sensitivity, with constant input signal amplitude under constant line voltage and frequency conditions, with rated ambient temperature variations. Expressed in percent of nominal sensitivity, usually ± around the nominal value. Measurements must allow equipment to reach thermal equilibrium at each ambient temperature.

BANDWITH—The frequency range over which the sensitivity of the recorder is with ±3db of a nominal or mean (arbitrarily selected) sensitivity. Usually, the mean value of sensitivity is defined as the zero-frequency value, since calibration is usually accomplished at DC. Expressed in cycles per second.

Note that the bandwidth is a function of peak-to-peak amplitude and the amplitude at which the measurement is made should be stated as a part of the bandwidth rating.

FREQUENCY RESPONSE—Similar to bandwidth, except that it defines the frequency range over which the sensitivity is within ±1% of nominal. Also a function of the test amplitude; see bandwidth.

BAND-AMPLITUDE PRODUCT (B.A.P.)—A figure of merit for direct-writing recorders which relates the bandwidth to the maximum peak-to-peak amplitude at which it is achieved. The product of the two is expressed in millimeter-cycles per second. Many different values of B.A.P. may be exhibited by a recorder, but the maximum B.A.P. is usually of greatest interest.

RISE TIME—The time required for the deflection to reach 99% of its ultimate (steady-state) value in response to the application of an (essentially) instantaneous "step" input signal infinitely prolonged. Affected by the signal amplitude, hence the test amplitude should be stated as a part of rise time rating.

CONTRAST—The difference in white-light reflectivity or transmissivity between the trace and the base-medium.

TRACE UNIFORMITY—The immunity of the trace to variations in width and contrast as the deflection, chart speed, and writing rate vary. Expressed in ± percent variation, in width (or contrast) over the entire range of rated deflections, chart speed, and writing rate.

MAXIMUM STYLUS RATE—The highest speed (with respect to the chart) at which the stylus can be driven under drive-signal or chart-speed condition. Expressed in millimeters/sec.

MAXIMUM WRITING RATE—The highest stylus rate at which the trace remains significantly unchanged (in contrast and width) from its low-frequency characteristics.

DEFINITION—The distinctness and clarity of detail with which a trace pattern can be drawn. Measured by determining the maximum number of distinctly separated traces that can be drawn parallel to the recording axis in a given length of chart paper. Expressed in lines/mm.

RESOLUTION—A measure of the smallest detail of information which can be meaningfully interpreted from the record. Affected by trace contrast and definition, by the maximum writing rate, and by the band-amplitude product. A convenient method for evaluating the resolving ability of the recorder is to determine the smallest, fastest (hence, lowest total energy) signal which may be superimposed on a standard test signal without significant loss of detail, or distortion. A convenient test signal is a low-frequency sine wave well within the frequency range of the recorder, at a level producing maximum rated peak-to-peak deflection. The superimposed signal may then, conveniently, be a narrow "notch" of controllable width and amplitude "cut into" the standard test signal. The ratio of test-amplitude signal area to the area of the notch is then observed.

MAXIMUM RESOLVING POWER (M.R.P.)—A convenient means of expressing the resolving ability of a recorder in terms of its electromechanical ratings. The product of the B.A.P. and the definition. Expressed in line-cycles per second.

Example

The following illustrates the use of the two most important figures of merit defined:

The AO TRACEMASTER recorder provides a bandwidth of DC-140 cps (±3db) at a peak-to-peak amplitude of 40 MM.

Thus, the Band-Amplitude Product is:

BAP = 140 cps x 40 mm
BAP = 5,560 mm-cycles/sec

The TRACEMASTER writing mechanism will produce at least 55 distinctly separable lines per centimeter, which yield a *definition* of 5.5 lines/mm. Thus, the *Maximum Resolving Power* is:

MRP = 5,600 mm-cycles/sec x 5.5 lines/mm
MRP = 30,800 line-cycles/sec

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by C. S. Beard. New "one-book" reference on control valves . . . covers flow characteristics; mechanical features; valve capacity; sizing; body types; positioners; actuators, including d-c, electro-hydraulic and gas hydraulic actuators. Numerous tables and illustrations. Paperbound, 236 pages, 1960 (revised edition).

Recording Welding Variables

Instrumentation associated with heavy-duty flash welding equipment records all machine operations that directly contribute to joint quality, thus reducing rejects and quality-control sectioning and etching.

L. S. WILKINS
Thomson Electric Welder Company

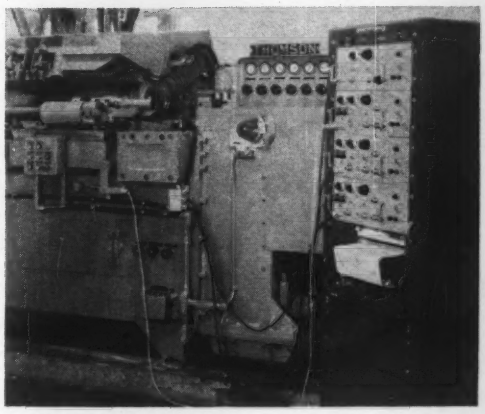


FIG. 1. WELDING MACHINE (left) with the Synchromatic mechanism (center) and Sanborn Series 150 recorder (right). Recorder plots four critical variables during the welding operation—primary weld current, platen travel, upset force, and forge force.

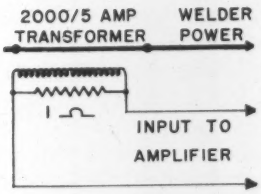


FIG. 2. WELD CURRENT is picked up from the secondary side of a current transformer across a 1-ohm resistor.

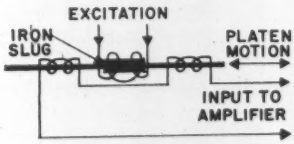


FIG. 3. PLATEN TRAVEL is measured by the current differential created by the displacement of an iron slug between the coaxial coils.

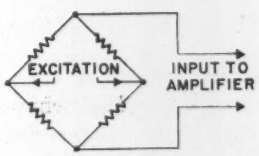


FIG. 4. UPSET and forge force are measured by load cells; upset by a compression cell; forge force by a tension cell.

PRODUCTION METHODS of a major electrical firm for manufacturing a new circuit breaker design include flash welding copper to copper, and copper to aluminum, in bar stock sizes of ⅜" x 6", ⅜" x 1½", and ½" x 3". To be assured that each weld measures up to quality control specifications, an elaborate instrumentation system is used to record the principal operating cycles.

The basic welding unit is a Thomson Electric F-5 model rated at 400 KVA at 50% duty cycle. The machine consistently produces welds of a predetermined characteristic at the rate of approximately one every 20 seconds, excluding load time. The quality of weldment can be analyzed quickly by examining traces recorded on a recorder (Fig. 1). Recorded are (1) primary weld current, (2) platen travel, (3) upset force, and (4) forge force

The *primary current* trace for a particular weld is picked up from a 1-ohm resistor connected across the secondary of a current transformer inserted in the 440-volt line to the welding transformer (Fig. 2). A current of 5 amperes, for example, flowing through the secondary of the current transformer, produces five volts across the resistor.

Platen travel is a critical variable and is recorded. In Thomson's flash welders this is regulated automatically by a patented Synchromatic mechanism. The motion transducer is a Sanborn Linearsyn, employing a differential transformer (Fig. 3).

Upset and forge force provide the third and fourth traces. Upset force is measured by a Baldwin Type C strain-gage load cell set between the Synchromatic mechanism and the platen. Forge force is measured by a tension load cell using a hook-up similar to that of Fig. 4. The tension cell is tied to a shaft of the dual force cylinders that are designed to pull the platen through upset.

During production, weld quality can be checked as often as control programs dictate. The equipment helps improve both product dependability and production efficiency.

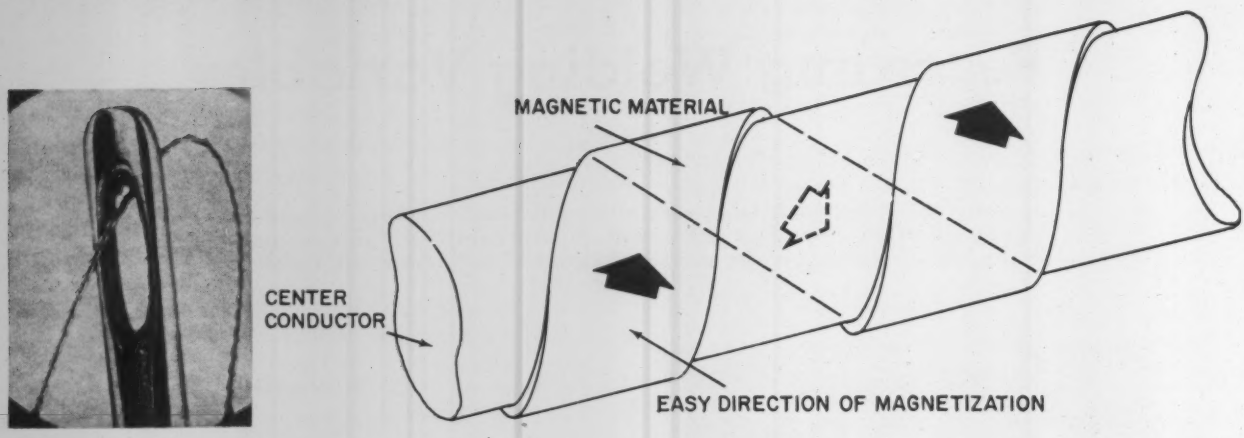


FIG. 1. WRAPPED TWISTOR. Arrows represent easy "1" state. Easy "0" state would be arrows in opposite direction. Element is smaller than eye of needle.

Twistor Memories

Memory based on a continuous low-cost wrapping of magnetic material on a single conductor has great promise for large low-cost memory system.

PHILIP N. McCABE

Burroughs Corporation—Laboratories
Paoli, Pennsylvania

THE DISCOVERY at Bell Telephone Laboratories by Andrew H. Bobeck that a *helical direction of magnetization* could be induced in a nickel wire by *torsion* led to the development of the "twistor."[1] The early embodiments of this device consisted of a small-diameter (0.005") nickel wire under torsion, and a copper conductor wrapped in the form of a solenoid around the circumference of the nickel wire. Current applied to the solenoid produced an axial field in the twisted nickel wire, causing a voltage to appear at the end of the nickel wire as a result of the changing magnetization. The twisted nickel wire has since been replaced by a wrapped structure (because of the impedance and resultant attenuation of the switching signal). The modern twistor does *not* use a wire under torsion.

Wrapped Twistors

In the twistors' present form a thin, narrow tape (or wire) of magnetic material is wrapped in the form of a helix on a copper conductor (Fig. 1). As the material is anisotropic*, it has an "easy" and a "hard" direction of magnetization. The easy direction of magnetization is along the helix as shown in Fig. 1.

The wrapped twistor is within a solenoid which produces an axial magnetic field H_A (Fig 2).

The wrapped twistor (with associated solenoid) is used in a linear-select memory as follows: A current applied to the twistor center wire produces a circumferential magnetic field. A current in the solenoid produces an axial magnetic field. When these currents are applied coincidentally, they produce a resultant magnetic field whose direction can be aligned with the easy direction of the magnetic tape.

Assume point A in Fig. 2 to be a point *on the surface* of one of the wraps of magnetic material of a twistor. When a circumferential field H_C of insufficient magnitude to change the state is applied in coincidence with an axial field H_A of insufficient magnitude to change the state, the fields add vectorially to give a resultant field which *is* strong enough to change the state—in line with the easy direction. The write-1 operation consists of applying currents as shown in Fig. 2. The write-0 operation is shown in Fig. 3.

The state of the twistor bit is read out by application of a large reversed solenoid field (H_R) which is of sufficient strength to swing the 1 vector counterclockwise from 1, past the hard direction, and toward

*i.e., magnetic properties depend on direction.

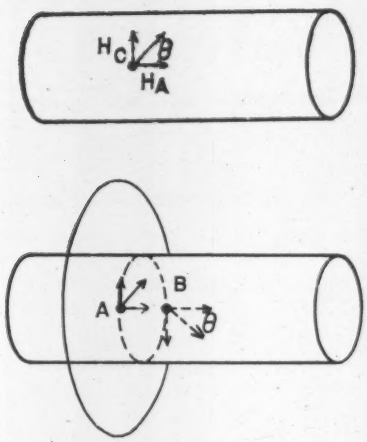


FIG. 2. APPLIED FIELDS H_0 and H_A produce easy 1 state. This is the write 1 operation. Point A is point on near surface of conductor. Point B is on far side of conductor.

the easy 0 direction (Fig. 4). During this time a voltage is produced by the changing flux, and sensed across the ends of the twistor center conductor. The read-0 action is shown in Fig. 5.

Characteristics

A typical set of operating characteristics are given for a twistor with a 0.015″-wide magnetic tape wrapped at a 30° angle on a 0.007″-diameter copper wire with a 0.005″ gap. The solenoid is 12 turns of #30 wire:

Write Current (Solenoid)	120 ma
Information Current (Twistor)	112 ma
Read Current (Solenoid)	500 ma
Disturbed One Output	39 mv
Disturbed Zero Output	6 mv
Switching Time	0.4 μsec.

Fabrication

A wrapping machine wraps a twistor by pulling a horizontal copper wire from left to right and at the same time rotating an arm, with a bobbin of magnetic material on it, around the copper wire. By varying the width of the magnetic material and the ratio of the advance of the copper wire to the number of rpm's of the bobbin arm, a wide variety of twistors can be wrapped.

Geometry Effects on Operation

Variation in geometry has two major effects on operational characteristics. The first is to change the cross-sectional area of magnetic material under the solenoid, thereby changing the output signal; the second is to change the angle between the easy direction of magnetization and the applied fields. As this easy direction is not in line with the applied fields,

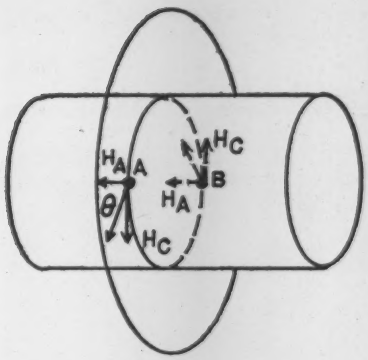


FIG. 3. WRITE 0 operation for point A (near side) and B (far side) on surface of conductor.

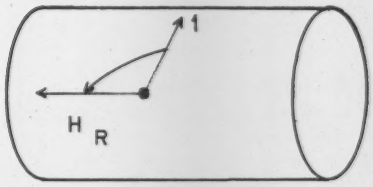


FIG. 4. IN READING a 1, the axial H_R field causes the 1 vector to rotate counterclockwise on near surface.

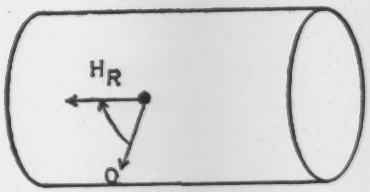


FIG. 5. IN READING a 0, the H_R read field causes point on near surface to rotate clockwise.

the twistor does not seem to be a square-hysteresis-loop device. As soon as the geometry of the twistor is changed so that the angle θ in Fig. 2 becomes, let us say, less than 45°, the axial field (due to current in the solenoid) sees an apparent increase in squareness and thus this field becomes more effective. In practical terms, this means that less solenoid current is necessary to saturate the twistor.

When the angle θ becomes greater than 45°, the circumferential field sees an apparent increase in squareness and it becomes more effective. Experiments have shown that, for an increase in angle from 30° to 60°, the necessary current changes by a factor of two. From the standpoint of economy, a low angle (30°) is the most economical because the larger current (the read current) is on the solenoid, and any decrease in this current effects a large saving. A high angle (60°) would seem to be the most economical

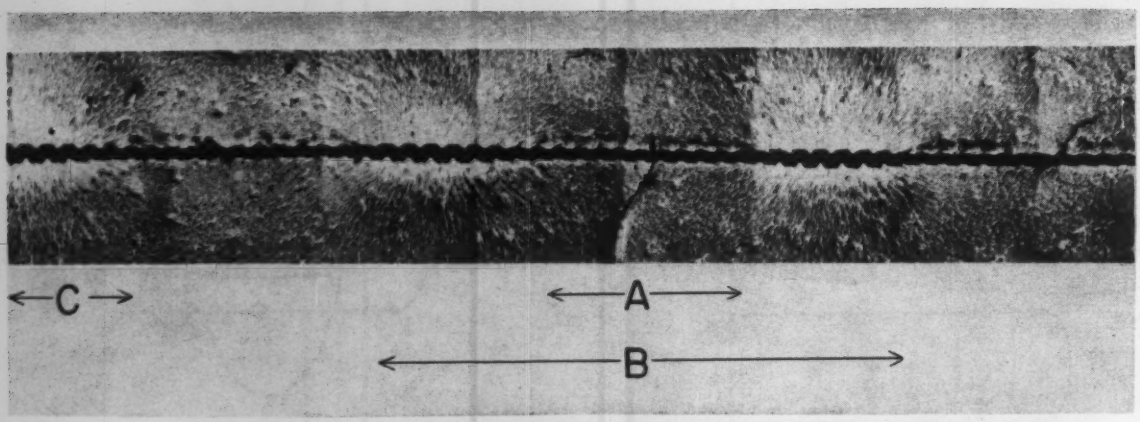


FIG. 6. A IS LENGTH of twistor in writing solenoid. B is effective length of twistor bit due to fringing of writing field. C is beginning of next memory bit.

for the output signal because this would give the greatest number of wraps of magnetic material per linear inch. However, since it is cross-sectional area that is important, a large output signal can be obtained by decreasing the gap between wraps of the magnetic material.

The increase in twistor wire current necessitated by a low angle can be off-set by wrapping the magnetic material on a small-diameter wire. Magnetic materials ranging in width from 0.015″ to 0.003″ have been wrapped on wire diameters from 0.010″ to 0.003″, with gaps from 0.020″ to 0.001″.

Twistor Geometry

A twistor bit in an actual memory is a fairly nebulous thing. This is a result of the fact that the flux path is not closed in the magnetic material (as it is in a toroidal core). Fig. 6 is a photomicrograph of a wrapped twistor. The entire twistor was magnetized from right to left, and then the section labeled B was switched so that it became magnetized from left to right. The twistor then was immersed in a colloidal suspension of iron-oxide particles, which were attracted to the free poles at the bit ends. The solenoid used to write the information into the twistor covered the section labeled A.

The fringing of the solenoid field is evident. The amount of fringing depends on the solenoid field strength and the demagnetizing field of the bit itself. The bit length has a tendency to increase (creep) under repeated partial switching, producing "cross-talk" or interference with adjacent bits. This effect can be reduced by (1) increasing the space between solenoids, (2) effecting a reverse field at each end of the solenoid, or (3) placing a shorting turn at each end of the solenoid.

The output of a twistor bit depends only on the cross-sectional area of magnetic material influenced by the solenoid. Typically, where the calculated cross-sectional area *under* the solenoid should give an output of 10 mv-μsec, the actual output is increased by fringing and creeping to 15 mv-μsec. This 50% increase in output is typical for calculated outputs of from 2 to 10 mv-μsec.

Twistor Encapsulation

The fabrication of long lengths of small-diameter wrapped twistors leads to a problem of handling. This problem has been solved by encapsulating from twenty to fifty lengths of twistor, side by side, in a thin sheet of plastic to give a package approximately 0.010″ thick by 2″ to 5″ wide, by any length. The belt, in which the twistor wires are on 0.100″ centers, is flexible and easy to handle. This form also has the advantage of eliminating the interplane connections.

As twistors are continuous, the belt, rather than being cut into individual planes, is folded back and forth on itself, necessitating connectors only at the top and bottom of the stack.

The magnetic material used in the twistor is unannealed and, therefore, relatively strain-insensitive. Thus the handling and folding of the twistor belt does not affect the magnetic properties. Experience has shown that long lengths of twistor (up to 4000 feet) can be wrapped[2] within a tolerance of $\pm 10\%$. The variations are such that no bit is completely bad; this eliminates the necessity of cutting out a bit and patching the wire.

The unannealed magnetic material has a relatively high coercivity (from 1 to 4 oersteds). This requires high currents in the word drive on the solenoid. The problem is compounded by the relatively poor coupling between the solenoid and the twistor. As the solenoid does not thread the twistor (as in a toroid), the coupling depends largely on the proximity of the solenoid to the twistor wire. Also, as the solenoid is not a long, thin solenoid, the uniformity of the field is poor and the strength of the field, as seen by the twistor, is sensitive to position. The coupling of the magnetic material to the conductor upon which it is wrapped is almost an order of magnitude better, and the currents here are in the order of 100 milliamperes.

Read Fields

In twistor memories, the high read-fields are obtained in one of two ways. The first is to use a current step-up transformer and a single-turn secondary. In this case, one ferrite switch core is selected from a matrix of cores by the coincidence of two currents. These two currents appear on a multiturn primary of the switch core. The secondary of each switch core is the single-turn word (or read winding) of the twistor array. This single-turn winding is usually a copper strip which encircles the twistor belt, 0.100" wide by a few thousandths thick.

The other type of word winding is a multiturn solenoid of from 5 to 15 turns of approximately #30 AWG copper wire (Fig. 7). The single-turn copper-strip solenoid can be placed close to the twistor belt so that its air inductance is very low, whereas the multiturn solenoid must be wrapped on a separate form from the twistor belt because the belt is not strong enough to support the solenoid; consequently, its air inductance is high—approximately 10 μhenries.

The air inductance of the multiturn solenoid can be reduced by placing a twistor belt on each side of a conducting plate and then wrapping the solenoid around this form. The conducting plate acts as an eddy-current shield, effectively reducing the cross-sectional area of the air under the solenoid. This method has the added advantage of increasing the package density because a twistor belt is placed on each side of the plate.

A fabrication advantage of a twistor array—namely, that it is only a two-wire system—is partially offset by noise considerations when a memory is assembled. As the sense wire (the twistor wire) is unidirectional throughout the memory, noise must be cancelled by placing a return wire in the twistor belt for each twistor, and treating the wrapped twistor and the return as a transmission line.

Nondestructive Read

The twistor memory operation up to this point has been destructive—that is, the read current always leaves the magnetic material in the zero state. In most memories, this information is automatically reinserted into the memory. However, the twistor can be modified to operate in a nondestructive manner. This requires the return of the twistor to its original state after readout, a condition that can be accomplished in two ways:

The first is to write with a long solenoid, and read with a much shorter solenoid in the center of the long solenoid. The long twistor-bit magnetized by the write solenoid is split into three sections during read time by the short read-solenoid. The two end sections, which are magnetized in the same direction, force the center section to return to their direction after the read field is removed, thus effecting a nondestructive operation.

The second method is to bias each twistor-solenoid intersection with a permanent magnet.[3] The field from the permanent magnet is strong enough to return the twistor to its original state after a read operation. Permanent magnets are placed on a card over each plane of the twistor memory and can be easily removed and replaced with a new pattern.

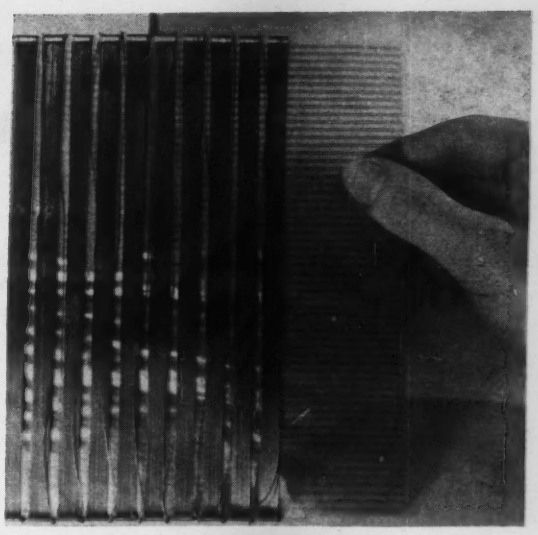


FIG. 7. THESE IMBEDDED TWISTORS form a twistor "belt"—a complete memory plane. Each pair of horizontal wires contains a twistor and a return conductor. The vertical wires are solenoids. A bit of information can be stored at the intersection of a solenoid and each twistor.

Twistors as Logic Devices

As a logic device, the twistor can be used to produce a *shift register* by using the fringing and creeping tendency of the twistor bit.[4] The design takes advantage of the intersection effect between closely spaced bits to slide a magnetized zone down a twistor wire with a multiphased clock pulse. (This is the only report to date of a twistor logic device.)

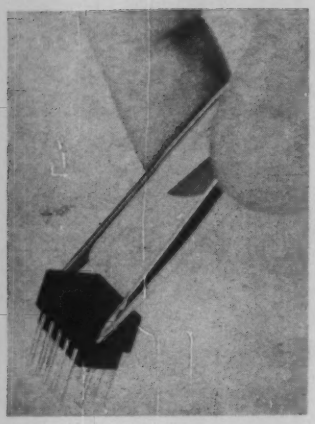
The twistor has operational characteristics and manufacturing capabilities of great promise. As its magnetic material is a metal, it can operate successfully at a high temperature. The 4-79 molybdenum permalloy from which most wrapped twistors are made decreases in output flux by 0.1%/°C for increasing temperature.

The ability to wrap a continuous rather than a discrete element, and to include a conductor in the same operation, lowers the cost and increases the twistor's reliability by eliminating a large amount of handling.

These advantages make the twistor a good candidate for large low-cost memory systems.

References

1. *The Bell System Technical Journal*, Vol. XXXVI, No. 6, Nov. 1957.
2. Andrew H. Bobeck, "The Twistor—Past, Present and Future," 7th Annual Conference on Computers and Data Processing, July 28, 29, 1960, Estes Park, Colorado.
3. *Ibid.*
4. A. H. Bobeck and Robert F. Fisher, *Journal Applied Physics*, Supplement to Vol. 30, No. 4, April, 1959, 43S-44S.



Magnetic Core Logic

Magnetic-core elements can be used to perform basic digital logic functions. Here is the basic core-transistor-logic (CTL) element.

ROBERT KODIS DI/AN Controls, Inc.

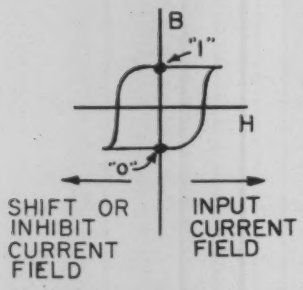


FIG. 1. MAGNETIZATION CURVE for an iron core. Field that saturates core is caused by a current. Input field saturates core in one direction called the "1" state; shift (or inhibit) field saturates core into "0" state. Core is always left in 0 or 1 condition. On readout, core always is returned to 0 state (destructive readout).

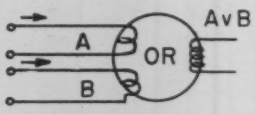


FIG. 2. MAGNETIC-CORE OR element comprises core which can be saturated by one or another of several inputs. In OR element both signals have same polarity.

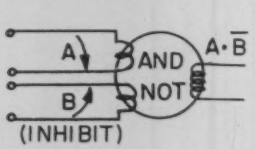


FIG. 3. MAGNETIC-CORE element can perform the AND NOT function by reversing polarity of the second input. If B appears with A, fields cancel and there is no core saturation. The only time the core is saturated is when A is present AND NOT B—that is, A and NOT B, or $A \cdot \overline{B}$. Note: A must be present; the signal $B \cdot \overline{A}$ will not produce an output.

LOGIC CIRCUITS can be built using a core that can be saturated in one direction or the other. The core also provides memory. The residual direction of saturation represents the two basic memory states, commonly referred to as 0 and 1. Fig. 1 shows these two states and the magnetic fields which produce them.

For read-in, the core is saturated into the "1" state by a field (H) caused by the *input current*. For read-out, the core is saturated in the opposite direction (called the "0" state) by a field caused by the *shift current*.

The shift current interrogates the condition of the core. If the core had been in the 1 state when interrogated, the resulting change in flux as the core "shifts" to the 0 state produces the output pulse. If the core had been in the 0 state, no change in state occurs when the shift field is applied, and there is no output.

Note that (1) this is destructive readout, and (2) if no input or shift current is applied, the core remains in its previous state of 1 or 0 remanent magnetism.

Logic Operations

All logic operations (store, transfer, branch, AND, AND NOT, OR, invert, etc.) can be performed with this one core circuit.

OR Logic

The two basic logic operations used most commonly are OR and AND. The OR function is realized simply with a core and several input windings, as shown in Fig. 2. A current in either the A or B winding will saturate the core in the 1 direction. Thus, the output winding develops the signal A υ B. That is, when the core is interrogated by a shift current (not shown in Fig. 2), an output will result which is equivalent to A υ B—meaning that the core had previously been saturated into the 1 state by either A *or* B.

Another way of achieving the OR function is to connect two or more signals to the same input winding. Either one then saturates the core into the 1 state.

FIG. 4. AND element has same opposing windings as AND NOT element, but uses NOT B as inhibit winding input. When NOT B is NOT present, B must exist. Presence of A saturates core and element performs an AND function.

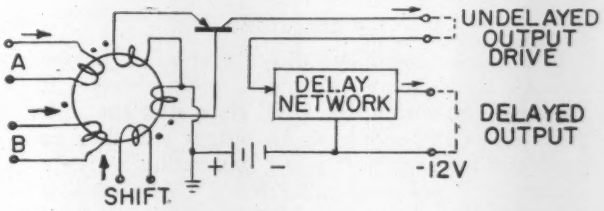


FIG. 5. CORE-TRANSISTOR-LOGIC (CTL) circuit. This one circuit type performs all logic functions of OR, AND NOT (inhibit), Store, Transfer, Binary Count, Invert (Complement), and Drive, with only one element.

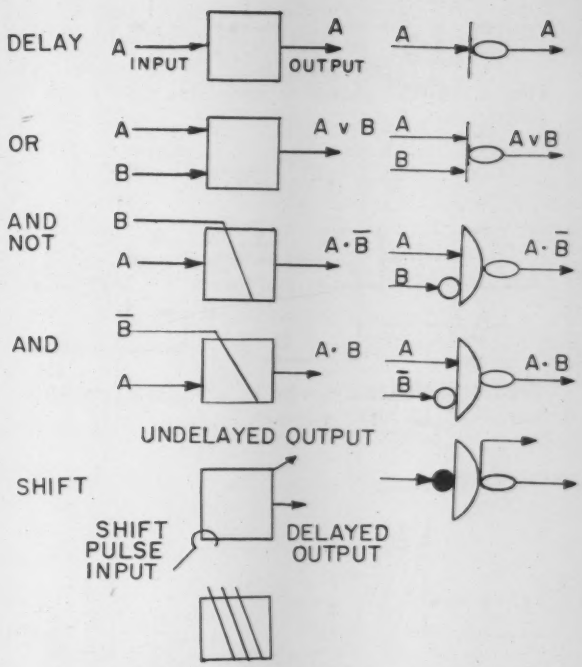


FIG. 6. SYMBOLS used in core logic. Style at left uses box to represent core; style at right uses conventional symbolic-logic symbols. An oval represents a delay.

AND NOT Technique

If one of the input windings has a current of reversed polarity, as shown in Fig. 3, the core can be saturated in the 1 state only when A AND NOT B exist. That is, A must exist in order to saturate the core in the 1 state. But if B exists it neutralizes the A signal because of its opposite polarity, and the core will not be in the 1 state. B alone will not produce a 1 state because of its polarity. Thus the 1 state can be produced only if A and *not* B exist. The output of the element in Fig. 3 can thus be expressed as $A \cdot \overline{B}$, and the element is referred to as an AND NOT element. The B signal of reversed polarity is called an *inhibit* current because it prevents A from saturating the core.

When the condition of the element in Fig. 3 is interrogated by a shift current (that is, the core is returned to the zero state), an output pulse will occur only if the signal $A \cdot \overline{B}$ had been present previously in the input. Stated differently, the core could have been saturated into the 1 state only by signals $A \cdot \overline{B}$.

The AND function (Fig. 4) results from the same AND NOT arrangement, but with the inhibit signal representing $\overline{B}$ rather than B. Now the core can be saturated into the 1 state only by an input representing A·B because (1) A must exist and (2) B must also exist because if it didn't then $\overline{B}$ would exist—but a $\overline{B}$ signal would cancel the A signal. Hence the core can be saturated only if A exists and $\overline{B}$ does not exist. This is the same as saying that A and B must exist. Expressed in symbolic-logic form:

$$A \text{ and NOT } \overline{B} = A \cdot B$$

Circuitry

Fig. 5 shows operational circuitry using cores for logic operations. The input logic signals A and B are applied to windings that can saturate the core. After the core is saturated, a signal in the shift winding shifts the core back to the zero state. If the core had been in the 1 state, a signal appears in the output winding. If the core has been in the 0 state, no signal appears in the output winding.

The shift pulse is usually clock actuated, and the core-setting input pulses arrive before the shift pulse. The delay between input and output (due to the shift technique) must be considered when using cores as logic elements.

There are several types of circuitry for using core logic elements—*Core-transistor-logic* (*CTL*) circuits have found widest use. The circuit shown in Fig. 5 is one of several forms available. The transistor and core form a regenerative blocking oscillator (in order to achieve fast switching action). The transistor is used only for amplification, not for storage, delay or logic.

The read-out (shift) current initiates or triggers the switching (reading-out) action. The read-out is executed by regenerative transistor current. This takes place only if the core had been in the ONE state, as described previously.

As the required triggering power is low, a core-transistor stage can serve as a driver to shift other

FIG. 7. "ONE" generator generates a series of 1 pulses.

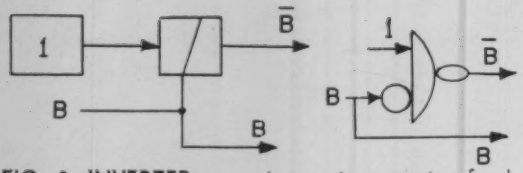


FIG. 8. INVERTER comprises a 1 generator feeding an AND NOT element.

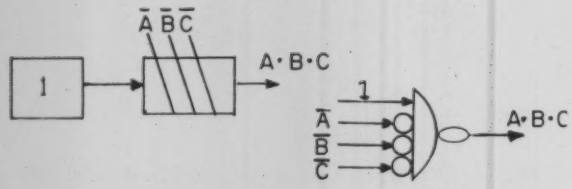


FIG. 9. AND gate, variation 1.

stages. This provides the ability to drive stages in cascade. Because of this ability to provide drive output, the core-transistor circuit offers flexible logic and control possibilities.

The core circuit can be operated at any frequency up to about 250 kc with present components. Restricted-logic versions have been built up to 500 kc.

No other circuit components are used between the CTL's in a logic structure.

Symbolic Representation

The symbols developed for single-phase core logic are shown in Fig. 6 using two symbol styles. The style at right uses symbols similar to those used previously in this series. The static storage capability of the magnetic core is represented by a box in the left group, and by an oval delay-element in the right group.

For the style at left, an arrow terminating on any side of the box is an affirmative (1) input. A line from a corner of a box represents an undelayed output. The AND NOT (inhibit) is represented by a straight line cutting across the box at any angle. The AND function shown is an AND NOT element with A and $\overline{B}$ inputs, as explained previously. When several coils are wound on one core, each is represented by a separate line.

For the style at right, the circle is an inverter, the oval is a delay, and the OR and AND gates are conventional.

The readout from a magnetic core is due to the action of the shift pulse. The output is generated by the shift pulse, and the shift pulse occurs at a time interval after the core is conditioned by the inputs. The interrogating shift pulse generates the output (1 and 0) depending on the *prior state* of the core.

The shift pulse can be represented by a hook placed about one corner of the box (left style in Fig. 6) or by a solid black circle in the "conventional" style at right in Fig. 6. However, the shift symbol is usually not shown on stages which are shifted directly from a common clock. The shift symbol is used only for the stages shifted (interrogated) by selected clock pulses or from other core logic elements, or from asynchronous outside timing.

The symbol at the bottom left in Fig. 6 represents three signals fed to one inhibit winding.

1 Generator

If a small continuous direct current is passed through the input winding of a logic element, it will reset the core to the ONE state after the shift pulse clears the core to 0. An output will thus be produced for each shift pulse, generating a steady stream of 1 pulses. Symbol for a 1 generator is shown in Fig. 7.

Inverter (Logical Complement)

Fig. 8 shows a 1 generator feeding its output to an AND NOT core element.

A pulse at B (see Fig. 3) inhibits the input action of the 1 coming from the 1 generator. Hence the core is not set to 1 and the next shift pulse produces no output pulse ($\overline{B}$). If no pulse is applied at B ($\overline{B}$) the 1 generator sets the core to 1, and the next shift pulse does produce an output pulse. Thus the output is 0 for B = 1, and is 1 for B = 0, which is inversion. This is a special case of the AND NOT circuit. Note that the $\overline{B}$ output occurs one clock time *after* the B inhibit (or whenever the shift is applied subsequent to the logic operation). This delay in logic output always must be considered in building logic structures.

AND Gates

The AND function can be achieved in several different ways, as shown in Figs. 9, 10, 11 and 12.

In Fig. 9, a pulse is delivered to the input winding from the 1 generator, and signals $\overline{A}$, $\overline{B}$, etc., are connected to the inhibit winding (or windings). If any inhibit signal is present, it will neutralize the input (1) signal, and no output will appear. An output can exist only if no inhibit exists—and this means that A·B·C must exist. Note that the circuit has one pulse-period delay—that is, the output appears one shift pulse after the inputs exist.

Fig. 10 shows another AND gate using two inputs (A and B) and one inhibit. As the number of inputs (2) is greater than the number of inhibits (1), this circuit can operate as an AND gate because A and B are each equal in magnetizing effect to the inhibit signal from the 1 generator, within a small controlled tolerance. (The core also has a tolerance due to the width of the hysteresis loop.)

If A AND B are both present, one of them will neutralize the inhibit, and the other will set the

core to 1, permitting readout of A•B by the *next* shift pulse.

In Fig. 11, core 3 and the 1 generator form the inverter described, and generate $\overline{B}$ (complement of B). This complement is delayed by one shift pulse from B. It is combined with the output of core 1 (which is delayed one shift pulse from A, restoring synchronism). Core 2 uses A-delayed as input and $\overline{B}$ as inhibit. Thus, an output occurs when both A AND B were present *two pulse intervals ago.* One core can be eliminated if B is available one clock time before A.

Fig. 12 shows another variation of the AND gate. Core 3 combines A and B in an AND NOT configuration, which produces an output when A AND NOT B are present. This inhibits core 2 which receives A (delayed by core 1). Thus, the necessary condition for setting core 2 to "1" is that there was an A AND B signal *one shift pulse ago.* (If there had been no B, then $A\cdot\overline{B}$ is read out of core 2, and inhibits A in core 3.)

Exclusive OR (Half-Adder)

Fig. 13 shows a symmetrical combination of two AND NOT gates which produces an output in the presence of A and not B, or in the presence of B and not A, but not under any other condition. Thus, an output is obtained only if A and B are different. This is the logic configuration for a "half-adder," which is expressed in symbolic-logic form as follows:

$$A\cdot\overline{B} \vee B\cdot\overline{A}$$

This circuit is used also in Gray-to-binary conversion, full adders, subtracters, comparators and DDA counters.

Flip Flop

Assume that the core in Fig. 14 is set to the zero state. An input pulse at A will set the flip-flop by setting the core to 1. The next shift pulse produces an output pulse which is fed back to the input. The feedback pulse will then set the core back to 1 unless an inhibit signal is present at B (the reset input). Thus, the flip-flop remains set until a reset (inhibit) pulse is fed to it, because it sets itself after each time the shift pulse clears it. This design is used frequently, and corresponds logically to an Eccles-Jordan flip-flop in d-c logic.

Counters

Fig. 15 shows a decade counter. This is actually a straight binary divider with a special feedback loop setting all stages back to the 0 state on the tenth count. The undelayed output of each stage drives the following stage, the time-delayed outputs of each stage reads into the following stage after that stage has been "cleared" by the drive pulse.

The delayed outputs also inhibit selected stages as shown. The decades can be cascaded directly. They also can be preset. As the core element consumes power only when it is shifting a ONE, the power consumption is low and is a maximum of twice the power used in the first stage, no matter how long the counter.

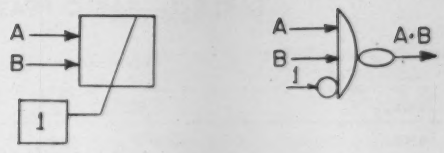


FIG. 10. AND gate, variation 2.

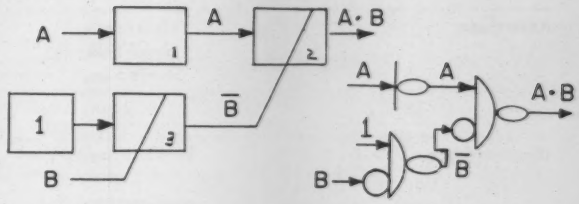


FIG. 11. AND gate, variation 3.

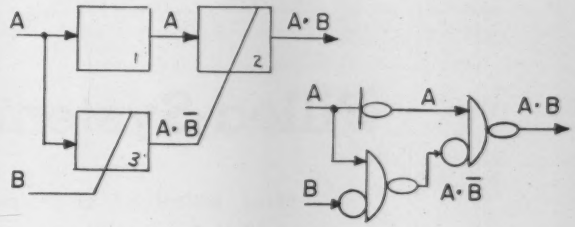


FIG. 12. AND gate, variation 4.

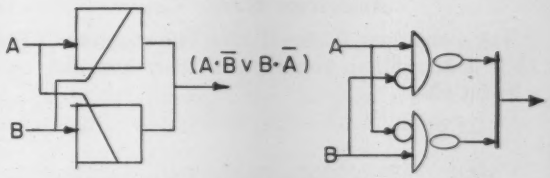


FIG. 13. EXCLUSIVE OR.

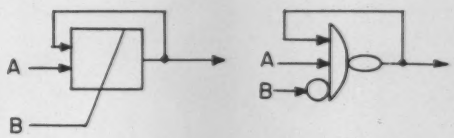


FIG. 14. FLIP-FLOP.

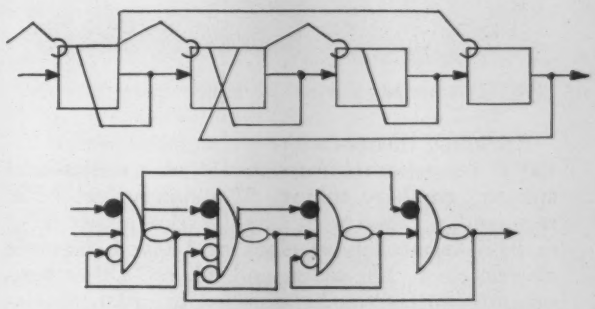


FIG. 15. BINARY counter.

TABLE 1—BASIC FEATURES OF FILLED THERMAL SYSTEMS

	Liquid	Mercury	Vapor Pressure	Gas
Max. Temp.	700°F	1200°F	650°F	1400°F
Min. Temp.	—300°F (usually —125°F)	—60°F (usually —38°F)	—300°F (usually —40°F)	—450°F
Max. Span	600F°	1200F°	400F°	1200F°
Min. Span	10F° (usually 40F°)	25F° (usually 100F°)	60°F (20F° below ambient)	120F° (50F° force balance)
Advantages	Linear scale; Small bulb; Shortest span		Lowest cost; Fastest response; No compensation required	Lowest temperature; Can withstand greatest over-range; Linear scale; Best for averaging
Disadvantages	Requires capillary and case compensation; Elevation error		Non-linear scale; Possible elevation error; Trouble or delay as temperature crosses ambient (except 11D)	Large bulb; Greatest temperature span required

Filled-System Thermometers

Most industrial and process temperatures are measured and controlled by these filled-system thermometers.

American Meter Co.

The American Class II-DL Thermometer (Fig. 1) is a dual-filled, vapor-pressure system that uses a linear chart.

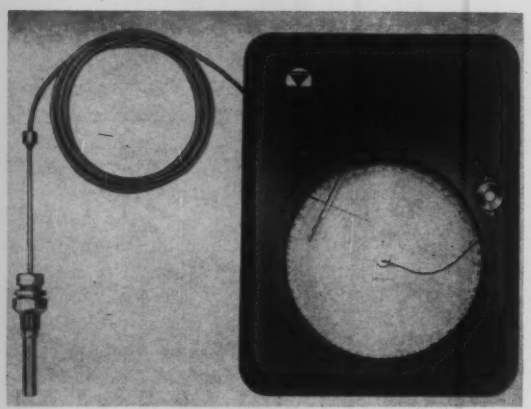


Fig. 1. American Class II DL temperature recorder.

Recording thermometers are supplied with a 0°-150°F temperature element, 15′ of stainless-steel armored capillary tubing, 2″ stainless-steel bulb, rectangular, vapor-proof case, Gasclok power drive or 24-hour mechanical clock or 110-volt, 60-cycle electric clock, 100 charts and ink set. Other temperature ranges can be supplied to order. Single-pen recorders for outside temperatures and two-pen recorders for inside and outside temperatures are available. Both types are supplied with a protective housing for the bulb.

Bacharach Industrial Instrument Company

Bacharach's Tempscribe gas-filled temperature recorder (Fig. 2) has 6′ of flexible capillary tubing. The recorder can be placed outside of a refrigerator or freezer at any convenient viewing point. Pen-operating mechanism is housed in the instrument door, which is removable. Pen deviation can be set to conform to a test thermometer reading by means of an adjusting screw. The instrument can be converted from one temperature range to another simply by replacing the door.

The chart is driven by a spring-wound clock movement, 24-hour or 7-day rotation. Charts are 4½″ in diameter, have uniform graduations, and are self-centering.

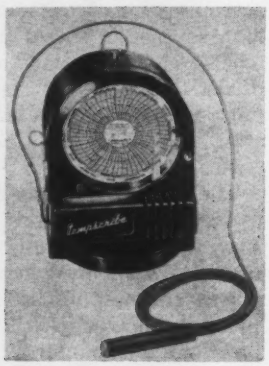


Fig. 2. Bacharach Tempscribe gas-filled temperature recorder.

TABLE 2—CLASSIFICATION

CLASS	FILLING	FEATURE
I	Liquid	Uncompensated
IA	Liquid	Case and capillary compensated
IB	Liquid	Case compensated
IIA	Vapor	Bulb above ambient
IIB	Vapor	Bulb below ambient
IIC	Vapor	Bulb either above or below ambient (uses large bulb)
IID	Vapor	Bulb above or below ambient—(uses nonvolatile-liquid transmission)
IIIA	Gas	Case and capillary compensated
IIIB	Gas	Case compensated
VA	Mercury	Case and capillary compensated
VB	Mercury	Case compensated
VC	Mercury	Capillary Compensated

Six ranges are available from −30 to +130°F. Special blood-bank recorder has −5 to +15°C range. Tempscribe doors also are available with electro-magnetic armature for recording cycling and total running time of refrigerator, fan, heater, etc.

Bailey Meter Company

A new mercury-filled temperature measuring system is designed as a standard plug-in unit for the Bailey Receiver-Recorder. The Bourdon-tube element in the new system (Fig. 3, top) plugs into

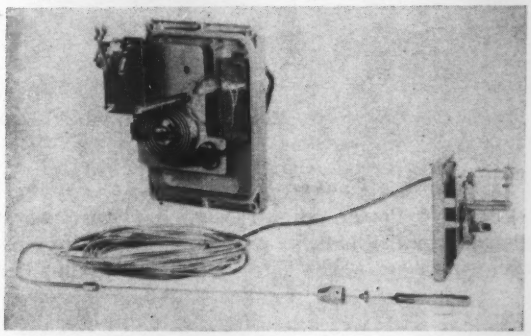


Fig. 3. Bailey mercury-filled system. Top shows receiver unit sized to fit any one of four locations in the recorder case. Note spiral Bourdon concluding in bimetal strip and means for repositioning element during calibration.

any of four positions in the recorder. Plain or coiled bulbs sense temperatures from −39 to +1200°F. Capillary ambient temperature error is limited to approximately ½% per 200 F° per 100′. Standard ranges are from 0-200°F to 0-1200°F. Supressed ranges also are available, with minimum spans of 188 F°.

The stainless-steel capillary in the mercury-filled system is compensated for ambient-temperature changes by a fine wire running through the center of the capillary tube. The difference in the thermal expansion coefficient of the mercury, capillary, and wire corrects for the thermal expansion of mercury. The receiver-recorder is equipped with a bimetal strip to compensate for errors created by ambient-temperature changes in the case. The over-all system has an accuracy of 1% of range. Response of 63% to a step change is 3 to 4 seconds.

The Mini-Line temperature transmitter (Fig. 4)

TABLE 3—AVAILABLE FILLED-SYSTEM THERMOMETERS

	Class I (liquid)	Class II (vapor)	Class III (gas)	Class V (mercury)
American		*		
Bacharach			*	
Bailey			*	*
Bristol	*	*	*	
Electric Auto-Lite	*	*	*	
Fenwal	*			
Fischer & Porter	*		*	
Foxboro	*	*	*	
General Controls	*		*	
Hays Corp.			*	
Manning, Maxwell & Moore		*	*	*
Marsh		*	*	
Mason-Neilan		*	*	*
M-Honeywell		*	*	*
Moeller				*
Moore Products			*	
Palmer	*			*
Partlow				*
Powers		*	*	
Taylor	*	*	*	*
Trerice	*	*	*	*
United Electric	*			*
US Gauge	*	*	*	*
Weksler	*	*	*	
Weston	*	*	*	*

pneumatically transmits the temperature measurement to indicating, recording, and controlling equip-

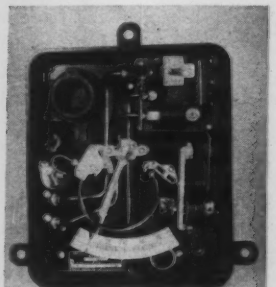


Fig. 4. Bailey Mini-Line temperature transmitter.

ment at remote stations. The transmitter also indicates temperature directly. Temperature measurement from 0 to 1200°F is achieved by a helium-gas-filled system (Class III) consisting of a temperature sensing bulb, 15′ of connecting capillary tubing, and a Bourdon tube.

The Bristol Co.

Bristol's indicating and recording liquid-filled systems (Fig. 5) are offered in various temperature spans ranging between −125°F and +600°F. A bimetallic strip, used on all case-compensated liquid-filled thermometers, automatically corrects for tem-

perature changes in the instrument case. Usually (for tubing lengths less than 10′) no further compensation is necessary. For tubing lengths greater than 10′, or where tubing is subject to wide temperature variation, the fully-compensated liquid-filled thermometer should be used.

The fully-compensated *liquid-filled* recording thermometer has two helical elements—one for measurement and the other for compensation.

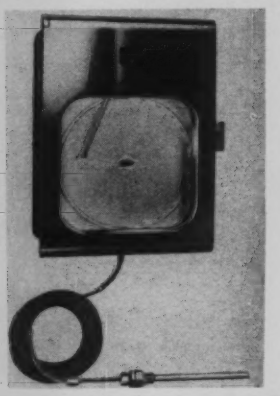


Fig. 5. Bristol filled-system thermometer.

Temperature range of Bristol *vapor-pressure* thermometers is up to 650°F. Model 1T500-2A is for measuring temperatures always higher than the temperature along the connecting tubing and case. Model 1T500-2B is for measuring temperatures always lower than the temperature along the connecting tubing and case. Connecting tubing can be 250′ or longer. Bristol dual-filled vapor-pressure recording thermometer, Model 1T500-2D is for temperatures between —20°F and +200°F. Minimum span is 50F°; recommended maximum span is 200F°.

Bristol also has developed a special linkage that provides uniformly-graduated charts for vapor-pressure thermometers—recommended maximum span is 150°F.

Bristol's gas-filled recording thermometer, Model 1T500-3B, is for temperature ranges between —125°F and +1000°F. The gas-filled thermometer lends itself well to measuring temperatures that vary over the full range of the scale.

Lengths of connecting tubing 250′ and longer have been supplied. A small-bulb gas-filled thermometer makes possible applications where space is limited. Compensation is by bimetal strip.

Electric Autolite Company

Autolite Model 2200 recording thermometers (Fig. 6) electrically etch a permanent trace on 6″ circular charts. Self-contained, mechanically driven or 110 V A-C driven instruments are available with 24 Hour or 7 Day chart rotations. Wall mounting, portable or portable self-contained versions

Fig. 6. Electro Autolite recording thermometer.

record temperature in ranges from —80°F. to +650°F.

Model F-1 indicating thermometer is liquid filled with choice of ranges from —60°F to +750°. Model V indicating thermometers have a vapor-pressure actuated movement. Standard ranges are between —40°F and +450°F. Dial sizes are 2½, 3½, 4½″.

Model GM indicating thermometers are available with 1, 2 or 3 SPDT snap-action, 5-ampere switches preset at factory. Temperature bulb can be air or liquid filled.

Fenwal Incorporated

Series 541 Indicating Temperature Controller is shown in Fig. 7. Pressure from expanding liquid within the bulb is transmitted to the bellows in the controller housing to actuate the indicating mechanism. The Series 541 Controller can control single or double circuits. A choice of five temperature ranges from —150°F to 700°F is available.

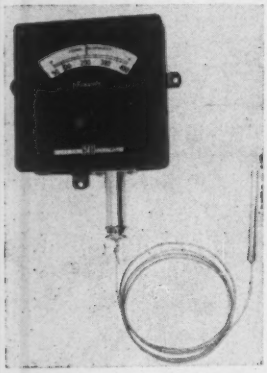


Fig. 7. Fenwal filled-system thermometer.

Fischer & Porter

Fischer & Porter (Fig. 8) employs two types of filled thermal systems to provide temperature measurements from —400°F to +1000°F—liquid filled

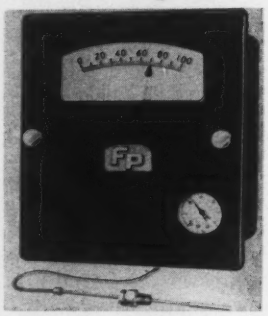


Fig. 8. Fischer & Porter filled-system temperature transmitter.

(Classes IA and IB) and gas filled (Class IIIB).

Liquid-filled systems are used when narrow spans (as small as 40 F°) are required. They give faster response, and use a smaller bulb than gas-filled systems. Limits are —100°F to +500°F. These have fully adjustable interconnecting linkages for individual factory compensation.

Gas-filled systems are case compensated and can be used between the limits of —400°F to +1000°F; minimum span is 200 F°.

Available bulbs include plain, capillary, averaging, flush, sheathed, and sanitary types. Protection and mounting accessories, such as wells, bushings and flanges are also obtainable.

Foxboro

Foxboro filled thermal systems (Fig. 9) include vapor pressure, gas pressure, and liquid expansion.

Liquid-expansion systems (Classes IA and IB) are for operating between −300 and +600°F. Both Class I systems include two separately-mounted helical elements, (Fig. 9). These have fully adjustable, interconnecting ball linkages which allow individual factory compensation of every system.

Foxboro liquid-filled systems are free from elevation error.

The fast-response vapor-pressure system (Class II) is for process temperature measurements between 100 and 600°F, or below ambient temperature down to −432°F. Ideal vapor-pressure applications are where process temperatures are relatively constant and remain above ambient temperatures,

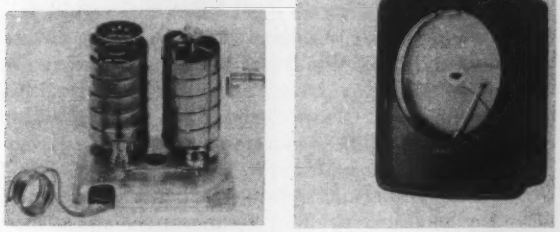


Fig. 9. Foxboro filled thermal system (right). Twin helixes (below) provide compensation.

or in cycle batching processes where final cook temperatures must be accurately recorded or controlled. It is customarily used in wet- and dry-bulb systems with wet-bulb temperatures from 100 to 212°F. Very-narrow-span (10 K°) systems are possible for the liquid-hydrogen-nitrogen-oxygen regions. Bulbs will stand up to +120°F.

Gas-pressure systems are for wide-span temperature measurements from −450 to +1000°F. This uniform-scale system is excellent for measurement spans of 400 F° or more. A long coiled bulb is ideal to measure average temperatures over a large area, as in ovens. These bulbs increase the speed of the system. This system is best for measuring temperatures of air or gaseous media undergoing wide cyclic variations.

Class III (gas) systems using strong, tapered wells measure superheated steam temperatures to 900°F. With special bulb construction and filling media, gas-pressure can measure temperatures as high as 1400°F.

In applications requiring exceptional element power, such as multi-contact electric control, a Class III system can be used in an M/44 Indicating Transmitter, or in a Type 12A Transmitter. These transmit pneumatically to a receiver instrument whose element provides sufficient power to actuate any alarm or control mechanisms.

Foxboro offers several types of lead bulb sheaths including Telurium lead, tin lead, antimony lead, or Nalco lead (for chrome plating baths).

General Controls Co.

General Controls' J-100 Series temperature instruments (Fig. 10) are liquid- or gas-filled with a C-type Bourdon tube. All units are available with

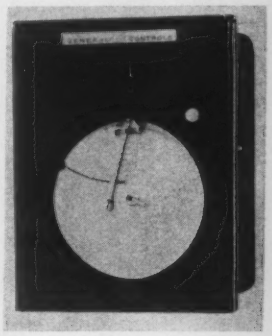


Fig. 10. General Controls filled-system thermometer recorder.

or without electric or pneumatic control in ranges from −100 to 1200°F. The line includes indicators, recorders, indicating controllers and recording controllers for flush or surface mount or portable fittings. They feature die-cast aluminum case and cover, stainless-steel movement throughout and simplicity of zero and range adjustment.

The Hays Corp.

Hays direct-acting temperature receivers (Fig. 11) use gas-filled thermal systems with bourdon springs for temperature measurement. A maximum of four records can be made on one chart. A gas-filled bulb or tube with 5′ capillary tubing is stand-

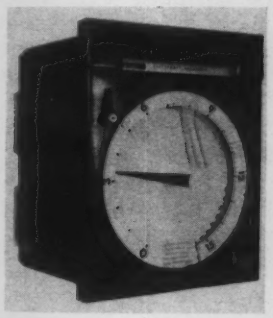


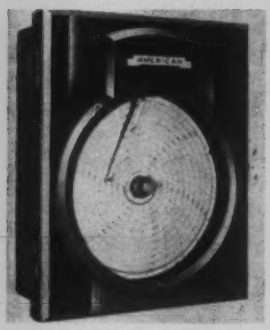
Fig. 11. Hays gas-filled temperature recorder.

ard; extended capillaries are available. Range is from 100°F to 1000°F. Maximum full-scale span 1000°F. Minimum span is 130°F.

Manning, Maxwell & Moore, Inc.

American filled-system instruments include mercury-actuated, vapor-pressure, and gas-actuated dial indicating and recording thermometers. Included in the vapor-pressure line are self-actuated temperature regulators.

American mercury-actuated dial thermometers respond quickly and powerfully to variations in temperature. "Magic Pulse" self-compensating capillary tubing assures accurate indication when used in widely varying ambient temperatures. "Magic Pulse" self-compensating mercury tube systems can be used at distances of 75′ out-of-doors and 150′ indoors. Line lengths to 240′ are available



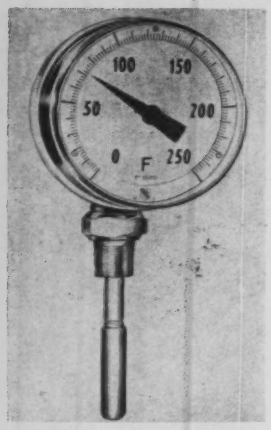


Fig. 12. Manning, Maxwell & Moore American filled-system thermometer recorder and indicator.

in ranges between the limits of —38°F and +1150°F where the entire capillary length is installed within an air-conditioned ambient.

Vapor-pressure-actuated dial thermometers provide scales that are progressive, with the distance between graduations increasing as the scale ascends. This provides greater readability at the high end of the scale. Vapor-pressure thermometers are recommended for service conditions requiring long lengths of capillary tubing and armor of special construction.

American gas-operated dial thermometers are suitable for the accurate indication of both high and low temperatures and for applications where mercury-actuated thermometers cannot be used.

All types of these indicating thermometers can be equipped with electric contacts to actuate an alarm. The contacts are rated ½ ampere at 110 volts ac or dc with non-inductive loads. These are available in high-low, double-high, and double-low. There is less than 1% differential between make and break. Palladium contact pointers guarantee long service life.

Marsh Instrument Co.

Marsh's vapor-pressure dial thermometers use a bourdon tube attached directly to the temperature-bulb. In the distant-reading type (Fig. 13) the bourdon tube is connected to the temperature element by a length of flexible tubing. Vapor pressure changes operate a geared movement which operates the indicating pointer. Available dial diameters are 2″, 2½″, 3½″, 4½″, 6″, and 8″. All have choice of 12 ranges, from —40 to +350°F.

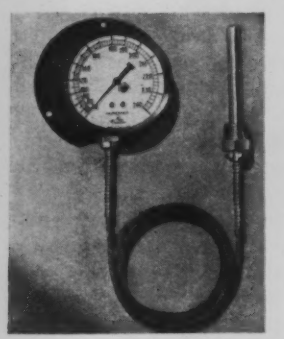


Fig. 13. Marsh vapor-pressure indicating thermometer.

The Marsh Type 59GD gas-filled adjustable dial thermometer is designed specifically for direct mounting into air ducts, kilns, and ovens. A 12″ copper-alloy stem is standard. Accuracy is ± one division over the entire dial range. Six ranges are available from —40 to +220°F. Six feet of capillary is optional. Dial angle is adjustable.

Mason-Neilan Division of Worthington Corp.

Mason-Neilan Vapor-Pressure Systems (Class II) provide 21 spans between 70 and 550°F. As the tubing is filled with liquid, correction for hydrostatic head must be made if the bulb and instrument are at different elevations. Standard system material is either copper or stainless steel.

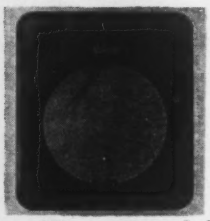


Fig. 14. Mason-Neilan filled system.

Mercury-filled systems (Class V) are suited for short or long spans between the temperature limits of —40° and 1000°F. Thirty-five spans are available. Special Invar compensation eliminates the effect of ambient temperature changes along the capillary tubing. These systems have no bulb elevation error. System material is always stainless steel.

Gas-Filled Thermal Systems (Class III) are suitable for medium to long temperature spans between the temperature limits of —100° and 1000°F. Thirty-one spans are available. There is no bulb elevation error.

Recorders can have control action.

Minneapolis-Honeywell Regulator Co.

Honeywell thermal systems (Fig. 15) are divided into three classes according to the fill material: vapor, gas, or mercury.

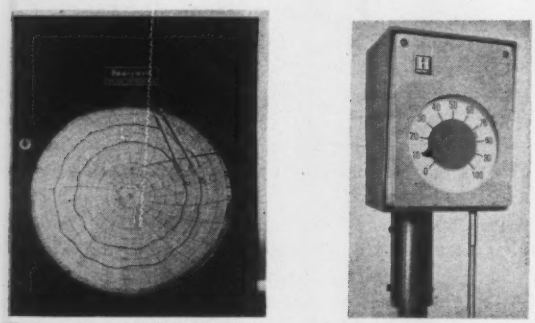


FIG. 15. HONEYWELL two-channel temperature recorder (left) and "bull's eye" transmitter (right).

Because of the large pressures that can result from over-range temperatures, vapor-actuated systems are not recommended for applications where over-ranges are likely.

Class II (vapor-actuated) thermal systems provide a temperature range from —40° to +600°F. Minimum temperature span is 60 F°. Vapor-actuated thermal systems are not suitable for use where

the ambient temperature is the same as, or close to, the measured temperature.

Class III gas-actuated vibration-resistant thermal systems use nitrogen as fill. The vibration-resistant thermal system uses a 316 stainless steel bulb that withstands highly corrosive applications. New design permits use of smaller bulbs for limited space applications and for wet bulb measurement so that small wicks with reduced evaporation can be used.

Bulbs are as large as practical to lessen the influence of temperature variations along the capillary tubing. Maximum length of capillary tubing is 175′. Temperature range is from −125°F to +800°F. Minimum temperature span is 150 F°.

Class V thermal systems use mercury fill and must be compensated for ambient-temperature variations, either at the case or at the case and along the entire length of the capillary tubing. Capillary compensation is obtained by use of a special wire (inside the capillary tubing) having negligible expansion due to ambient temperature changes.

Case compensation (bimetal strip) is sufficient when none of the extension neck is at bulb temperature, and when ambient temperature along the capillary does not vary widely.

Bulbs with long extension necks, or widely-varying ambient temperatures along the capillary, require both case and capillary compensation. Bulb size depends entirely upon the temperature span. Maximum length of capillary tubing is 150′. Temperature range is from −40°F to +1000°F. Periodic recalibration may be required at temperatures exceeding 800°F.

Bulb or instrument case elevation will have no practical effect on operation as long as this difference does not exceed 30′. Over-range of 150% can be withstood.

Two temperature *transmitters* feature the Honeywell line. The Tel-O-Set is a small adjustable span, helium-actuated Class III non-indicating temperature transmitter which transmits a proportionate pneumatic signal (3-15 psi). Without changing parts, the unit can be adjusted to any span from a minimum of 50°F to a maximum of 1000°F. This span, in turn, can be adjusted to fall anywhere within the over-all range from −50°F to +1000°F.

A new "bull's eye" temperature transmitter uses either a gas- or mercury-actuated thermal system and transmits a standard 3-15 psi signal which varies in proportion to changes in the measured temperature. It features a temperature-compensated rebalancing capsule which minimizes zero and span shifts due to ambient temperature change.

Moeller Instrument Company, Inc.

Moeller mercury-actuated dial thermometers are furnished in 4½″, 6″, and 8″ sizes for flush or surface panel mounting. Anti-parallax dial face is standard. Standard ranges are from −40°F to +1200°F. Tubing length can be up to 150′; case and capillary compensation (Class VA) is advised for tubing lengths over 50′. All instruments are supplied with case compensation (Class VB), and can be furnished with adjustable high and low alarm contacts (Fig. 16).

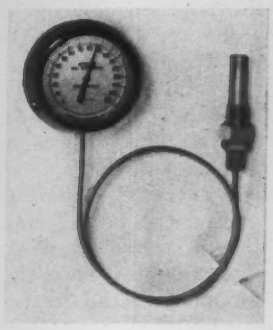


Fig. 16. Moeller mercury-filled dial thermometers are available with screwed sockets, flanged sockets, Van Stone thermowells and other types, in a wide variety of materials.

Moore Products Co.

Nullmatic Temperature Transmitters (Fig. 17) are Class III (gas-filled) systems. The pressure of

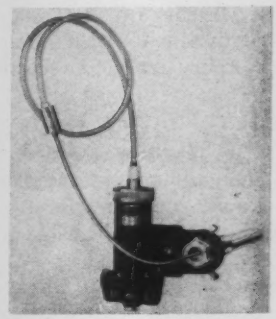


Fig. 17. Moore helium-gas-filled temperature transmitter.

the gas in the thermal element is converted by a bellows into a frictionless straight line force which acts on a spring-diaphragm type transmitting unit.

Standard 3-15 psi transmission signal has a direct linear relationship to the range of temperatures measured by the bulb and permits the use of uniformly-graduated scales. Ranges are available from −150°F to 1000°F.

The output is sensitive to changes in process temperature as small as 0.01% of full scale. Time required for indication of 63.2% of a temperature change through 100′ of ¼″ O.D. tubing is as follows:

Bare copper bulb—0.02 min.
Bare SS bulb—0.03 min.
Cu bulb in Cu socket—0.3 min.
Cu bulb in SS socket—0.6 min.

Available bulb sizes are: ⅜″ x 4″, ½″ x 6″, ¾″ x 4″. Averaging type is 14′ long in 6″ coil.

Maximum air consumption in a balanced condition, on dead-end service is 0.08 scfm (with 20-psi supply).

Palmer Thermometers, Inc.

The Palmer direct-drive dial thermometer (Fig. 18) contains a precision-wound double bourdon coil, directly attached to the pointer shaft and

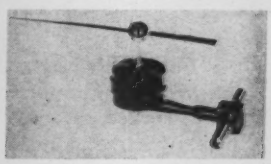


Fig. 18. Palmer direct-drive indicator is attached to the bourdon spiral.

supported by bearings mounted in an adjustable plate. The arrangement of the coil and shaft permits the pointer to operate directly from the center of

the bourdon coil and eliminates the conventional sector and pinion-type movement with its multiplying action. This design is especially suited where vibration exists.

Model 50-A rigid-stem dial thermometer has a tapered bulb that is interchangeable with standard industrial thermometer separable sockets. Stainless-steel case is adjustable to easy reading position.

Model 50-B wall-mounted dial thermometer has flexible armor—5′ is standard length; 60′ is maximum length. This thermometer can be flush mounted. Standard ranges are from −30°F to +1200°F.

A 4½″ dial thermometer can be furnished with a single electric contact to operate on either rising or falling temperatures; contact rating is 110 v, 25 watts, maximum.

Mercury fill is standard; liquid fill is optional on rigid-stem dial thermometers. A 12″ circular-chart mercury-actuated recorder also is available.

The Partlow Corporation

All Partlow thermal elements (except the CN element) operate from thermal expansion of pure liquid mercury. Its expansion exerts a powerful force on the flexible diaphragm located in the element head (Fig. 19). The diaphragm transmits this same force to the spring-loaded element plunger. Thus the diaphragm transfers the expansion to a linear motion. Because this force is powerful, there is no need for amplification. Valves and switches can be worked directly.

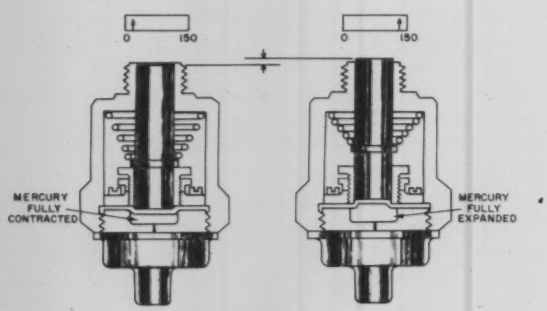


Fig. 19. Partlow's basic plunger movement. At left, plunger, diaphragm and mercury are fully contracted at the low end of the range. At right, plunger and diaphragm are shown raised with mercury fully expanded at the high end of the range.

Fig. 20. Partlow Model TMF indicating thermometer.

Partlow instruments (Fig. 20) cover a temperature span from −30°F to +1100°F. Eleven spans are available and most differ in their total number of degrees from top to bottom of scale. Yet every calibrated thermal element, regardless of its range, is calibrated so that the element plunger moves a uniform amount in total travel from one end of its span to the other. This enables control mechanisms to be identical for all temperature ranges. A control body can be used with any range my merely changing its dial to correspond with the element range. Regardless of the variance of bulb diameters, volumetric content of mercury will remain the same for each range.

The only bulb manufactured by Partlow which uses mercury in vapor form is the CN bulb. It was designed solely to operate uncalibrated safety devices where precise plunger travel is not critical.

Under normal operations, the CN bulb is subjected to the direct flame of a pilot burner where the bulb is heated to a red heat (1200 to 1400°F). The mercury vaporizes and the mercury vapor exerts a pressure against the element plunger. This holds either a switch or valve in its operating position.

The Powers Regulator Co.

The Series 100 Temperature Regulator (Fig. 21) is available in direct or reverse action, 1-point indicating, 1- or 2-pen recording. It is furnished with positive action for on-off control, or wide-range throttling with manual reset or automatic reset for continuous processes. The system is Class II or Class III with temperature limits of −110 to +600°F. Case is adaptable to flush or surface mounting. Temperature adjustment is behind hinged, locked cover.

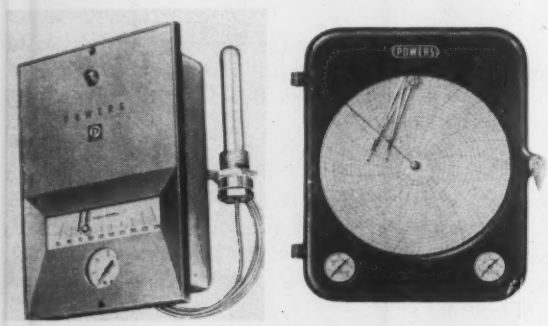


Fig. 21. Powers Series 100 recorder (right), and Series 200 temperature regulator (left).

The Series 200 Indicating Regulator (Fig. 21) has a Class III thermal system. Control action is direct or reverse and can be easily changed in the field. Throttling range is adjustable between 0% and 35% of scale. Temperature ranges are −25 to +135°F, 25 to 250°F, and 150 to 350°F.

The Series 200 Transmitter converts a temperature measurement into a 3-to-15 psi air pressure signal which is transmitted to a Receiver-Controller. The Receiver-Controller is located remote from the point of measurement and all changes in temperature set point are made at the Receiver-Controller.

Taylor Instrument Companies

Taylor 61K to 64K Series 6″ dial indicators (Fig. 22) are available with mercury, vapor, gas, or Monolex® organic liquid filled thermal systems. Standard connecting capillary is 5′; lengths to 200′ are available at extra cost.

Taylor offers dial indicators equipped with an electric contact mechanism that consists of a contact mechanism in the gage and a transformer-relay

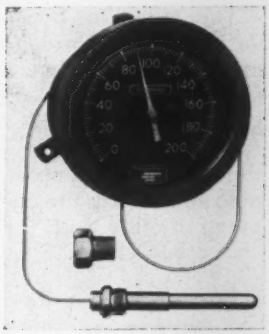


Fig. 22. Taylor 61K dial thermometer.

mounted apart from the gage. High and low contacts can be adjusted to any desired set point simply by moving them with the fingers. Standard 110-v or 220-v lights, bells, horns and solenoids can be handled by the relay contacts. Contacts available include high signal (rising alarm), low signal (falling alarm), or high-and-low signal (rising and falling alarm),—all with pushbutton or automatic release.

H. O. Trerice Company

Trerice offers mercury-, vapor-, liquid-, and gas-actuated thermometers, recorders and controllers.

Trerice 6″ Mercury-Actuated Dial Thermometers (Fig. 23) are furnished with stainless-steel bulb, capillary, and bourdon spring welded into one piece and solidly filled with mercury at high pressure. This high initial pressure insures quick response to

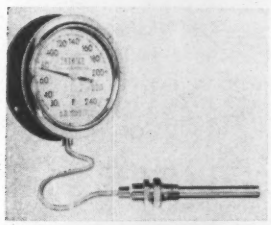


Fig. 23 Trerice 6″ mercury-filled dial thermometer.

slight temperature changes. Compensation is provided in the instrument for fluctuating room-temperature changes. Nine standard ranges, from 0 to 1000°F are available. Adjustable contacts can be furnished with single (high or low), or double (high and low) contacts. The contacts are designed for 1 amp at 110 volts ac or ½ amp at 220 volts ac.

An electric contact arrangement can be furnished for any Trerice Recording Thermometer.

United Electric Controls Co.

United Electric offers filled-system temperature controllers (Fig. 24), some of which also indicate

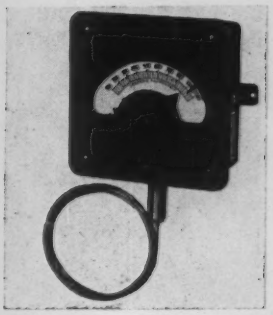


Fig. 24. United Electric indicating temperature control.

temperature. Snap-action switches can be NC, NO, or double throw. Single or dual switch units are available. Measuring or switch-driving element is a bellows. Systems are liquid or mercury filled.

Ranges are available from −150°F to +1000°F. Span can be 100°F or 200°F or more.

United States Gauge Division of American Machine and Metals, Inc.

USG thermometers (Fig. 25) provide choice of four types of actuation—mercury, vapor pressure, gas, and organic liquid; temperature switches and temperature alarms are optional. Bimetallic (case) compensators are standard in mercury and organic-liquid filled Supertherm thermometers.

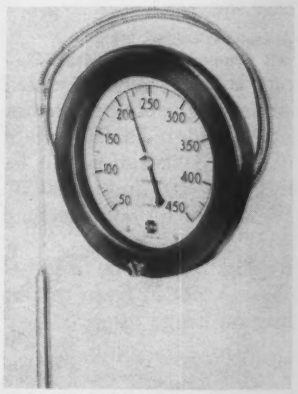


Fig. 25. U. S. Gauge Supertherm.

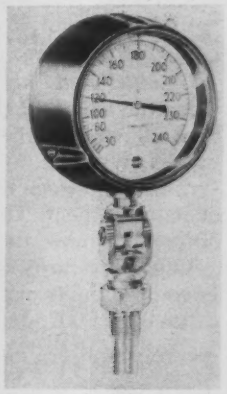


Fig. 26. Multi-Angle.

"Multi-Angle" Supertherm Thermometer (Fig. 26) has a special swivel-type mounting head. Dial sizes are 4½″, 6″ and 8½″ only.

An indicating temperature switch (available with vapor or gas actuation) is adjustable over the entire range with a minimum on/off differential of 3% of pointer travel. Contacts are rated at 10 amps, 115 v ac. A second thermal measuring system is used for indication, which permits indicating and switching to be independent.

Weksler Instrument Corp.

Weksler filled-system dial thermometers (Fig. 27) are furnished with liquid, gas or vapor actuat-

ing systems. The bulb, capillary system and actuating spring are welded into an integral unit.

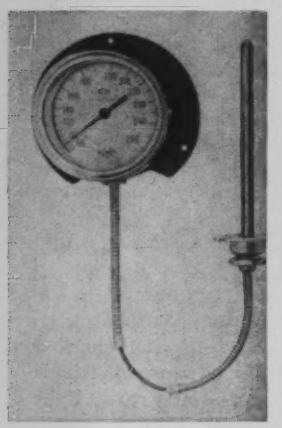


Fig. 27. Weksler vapor-pressure dial shows scale expansion at upper end of range.

Weksler thermal systems are sealed under high pressure. Because of this high initial pressure the actuating spring element is always under tension and response to temperature change at the bulb is fast. A second capillary tube and spring provide total compensation for ambient temperature changes on lines up to 250'.

Weston Instruments Div. Daystrom, Inc.

Weston offers the following filled systems:

Liquid Filled (standard compensation)—Class IB
Vapor Pressure—Class II
Vapor Pressure (dual filled)—Class IID
Gas Filled—Class III
Mercury Filled (standard compensation)—Class VB
Mercury Filled (AMBINUL) (self compensation)—Class VC

Liquid-Filled actuation is not recommended when the length of the connecting tubing is greater than 10' due to the relatively high coefficient of expansion of the liquid. Class IB actuation can be furnished between the limits of −100 and +500° F, or its equivalent. The span should be not less than 50° or not more than 250°F.

Vapor-Pressure systems (Fig. 28) can be used between the limits of −30 and +500°F. Span can be as small as 200°, depending on range required.

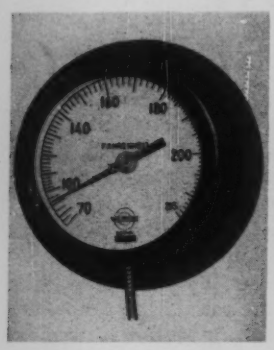


Fig. 28. Weston vapor-pressure dial indicator.

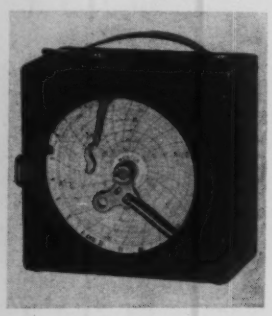


Fig. 29. Weston spring-wound portable vapor-pressure temperature recorder for use in trucks, vans, etc.

Gas-filled-systems temperature range is from −325 to 1000°F. Minimum span is 150°F. Scales are evenly graduated.

Metal-Case Distant-Reading, and Fixed-Stem Dial-Indicating Thermometers can be furnished with an adjustable silver pin contact. The contact pointer can be set at any point on the scale for a maximum or a minimum temperature. Whenever the temperature at the bulb reaches the set point, a vane on the underside of the indicating pointer makes contact with the silver pin. Maximum permissible contact load is 0.2 amp at 100 v ac noninductive or 0.1 amp at 110 v dc.

The Miniature Recorder shown in Fig. 29 was designed for recording temperatures accurately in mobile refrigerated vehicles which transport perishable or frozen foods. The pen writes reliable temperature records while in transit over rough highways or uneven roadbeds. The two-pen recorder is the same size. The second pen is actuated by a solenoid and records the operation periods of an electric motor or other load.

Regulators

Filled-systems (Figs. 30-33) are used commonly in regulating systems, usually to control a valve directly, with no external source of power required.

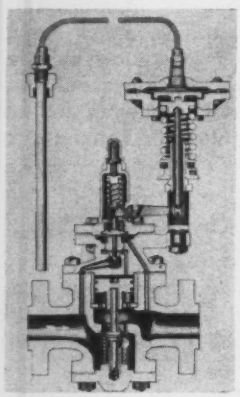


Fig. 30. Leslie Duo-Matic self-contained vapor-filled regulator.

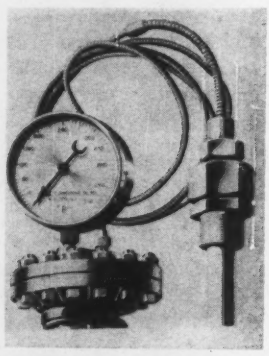


Fig. 31. Spence indicating temperature pilot uses vapor pressure.

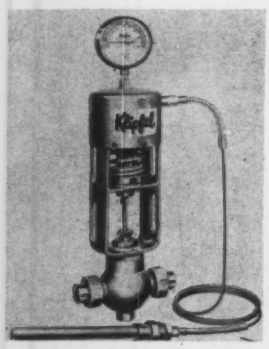


Fig. 32. Klipfel Model K is vapor-pressure actuated.

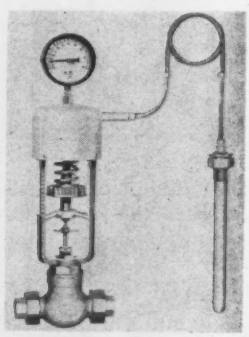


Fig. 33. Robertshaw-Fulton filled-system regulator.

Filled-system regulators will be described in a survey now in preparation. This survey will update the extensive series on regulators that appeared last year in *I&CS*.

Temperature Control by Stepped Resistance

HAROLD ESKIN
Electric Regulator Corporation

Small displacements can provide on-off, stepped, or continuously-variable electric signal output.

A REGOHM Transducer (Fig. 1) can be used with pressure-type thermometers to provide proportional temperature control. Useful control power on the 200-watt level appears at the transducer's output without the need for amplifying devices. As the transducer actuator moves through only 0.20", and requires force levels as low as 5 grams, an expansion sensor can provide ample drive.

The actuator arm (Fig. 2) drives the lift bar about the pivot, producing vertical motion of the lift-bar. The lower edge of the lift bar is cut at an angle. This moves the contact fingers to or away from the common bar to open or close each contact in sequence. A closed contact connects its resistor in parallel to those connected by the other contacts. Thus, actuator motion results in stepped resistance changes.

A top plate is added to support a pair of springs and a "dither" coil. The coil, energized from a 60-cycle source, produces a force which increases and decreases 120 times per second. This "dither" averages the resistance values, making the resistance changes smooth and stepless. Dither also eliminates static friction so that slight force changes (less than a gram) are sufficient to produce changes in transducer output.

The transducer can control any quantity which will cause motion of its actuator position—for example, control of tension from a dancer arm, pressure from a bellows or a bourdon tube, temperature from a bimetal strip or expansion element, displacement from a cam, spring, etc.

Electric connections from the contact fingers are brought out of the enclosure through pins at the bottom. The resistors are separate from the sensing device and can be mounted in any location. They can be changed to vary slope or profile of the resistance curve. Resistance can be from 15 ohms to 10 K ohms, in 19 standard ranges. The Regohm transducer is available in 10- and 20-finger models, which can accommodate up to 120 and 240 watts maximum, respectively.

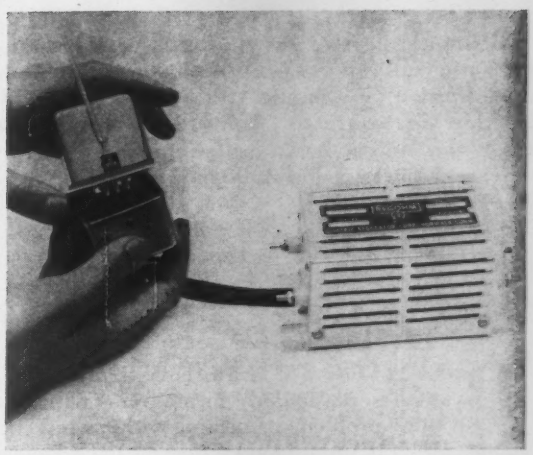


FIG. 1. REGOHM transducer plugs into socket which is mounted on device to be controlled. Linkage rod (top left) couples to mechanical movement. Change in the rod's position, as small as 0.0001", enables the transducer to control up to a quarter kilowatt of power.

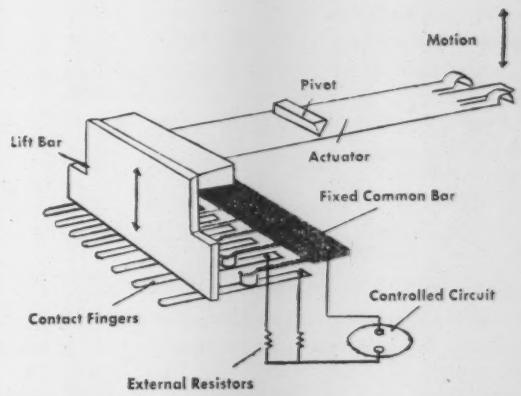


FIG. 2. PIVOTED ACTUATOR arm moves lift bar which closes (or opens) contacts sequentially.

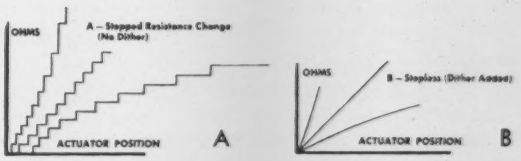


FIG. 3. AS THE LIFT BAR moves up, additional resistors are connected in parallel, thus decreasing total resistance. The last contact made can shunt all resistance. This is shown at A where curves go down to zero resistance. Various slope profiles can be made by selection of resistance values as shown. Dither, vibrating the actuator arm, produces stepless transition of resistance as shown at B.

Pneumatic Digital Computer

Pneumatic devices can be built with response time comparable to electronic components, and higher packing density. A pneumatic digital computer can operate in temperatures to 2000°F, and in any radiation environment. A bistable element which operates on compressed air or gas has a switching time as short as ten microseconds, and can be packaged at 3000/cubic inch.

HUGH E. RIORDAN

Kearfott Division

General Precision, Inc.

PNEUMATIC SYSTEMS have many basic advantages, particularly in programs with severe cooling problems associated with control equipment. Hot-gas servo-motors already have been developed, and use of gas as an operating medium is a natural approach to high-temperature-system problems. The extension of pneumatic techniques to digital computing is a logical development, and compact pneumatic digital computing devices have been built with response times comparable to electronic components.

It is feasible to build a pneumatic digital computer with even higher packaging density than comparable electronic computers, and capable of operating at clock frequencies to 100 kc.

All digital operations are combinations of three basic functions—(1) counting, (2) switching or logic, and (3) memory. In addition, at least some of the following functions also are required—time reference generation, power amplification, time delay, time scaling, and signal conversion. These functions can be performed pneumatically.

The pneumatic computer uses pneumatic techniques to produce (1) a diode, (2) a bistable element, (3) resistance, (4) inductance, (5) capacitance and (6) an acoustic transmission line.

The Pneumatic Diode

In pneumatic circuitry, an orifice operating above critical flow (that is, with gas flowing through the throat at or above the speed of sound) is a "diode." For such flow conditions, a pressure disturbance originating upstream of the orifice will propagate downstream through the orifice, but a disturbance originating downstream cannot propagate upstream past the orifice. This well-known critical-flow effect results from the fact that the speed of pressure propagation is the speed of sound, and the downstream flow through the orifice is greater than the speed of sound. Hence critical flow is independent of downstream pressure.

The ratio of supply to discharge pressure across an orifice for critical flow is roughly 2/1 for most gases—that is, for critical flow, the upstream pressure must be twice the downstream pressure, or greater. Thus, extensive cascading of critical-flow orifices requires high supply pressures, unless buffer amplifiers are used.

Pneumatic R, C and L

A pneumatic *resistance* is an orifice or capillary. Thus instrumentation of simple resistance circuits involves merely the appropriate inter-connection of orifices or capillaries of various sizes.

Pneumatic *capacitance* is a plenum chamber; pneumatic *inductance* is a long pipe of sufficiently large diameter that viscous losses do not predominate.

Pneumatic Bistable Element

A pneumatic bistable element is shown in Fig. 1. The basic element consists of a ball moving freely, but not loosely, in a cylindrical housing having four tubular connections. The various connections are numbered 1 through 4, and the two stable positions of the ball are designated A and B.

This device can be operated in a number of different ways; one simple connection is shown in Fig. 2. The two axial connections (1 and 2) are supplied through separate flow-restricting orifices by a common pneumatic supply at a pressure P_s. The radial connections (3 and 4) are open to the atmosphere. The ball is initially at position A.

Under these conditions, inlet 1 is closed by the ball; hence no flow occurs through its supply orifice and the pressure at 1 is equal to the supply pressure. Flow occurs, however, through the supply orifice for inlet 2, out through 4. As the ball does not provide a leaktight fit in the cylinder, a small flow passes around the ball and out through 3. Owing to the flow through orifice 2, there is a pressure drop δ across the lower orifice, and the pressure at 2 is $P_s - \delta$.

The forces on the ball are the resultant of (1)

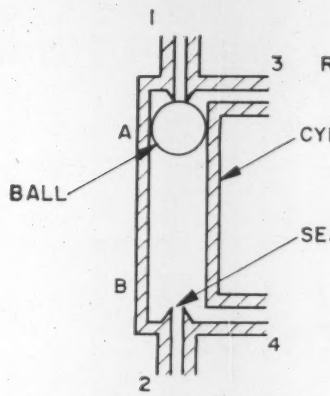


FIG. 1. **BASIC** bistable element.

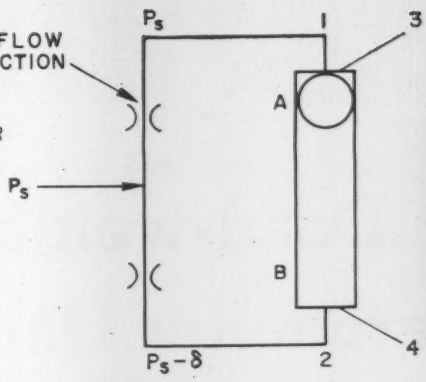


FIG. 2. **BISTABLE** circuit.

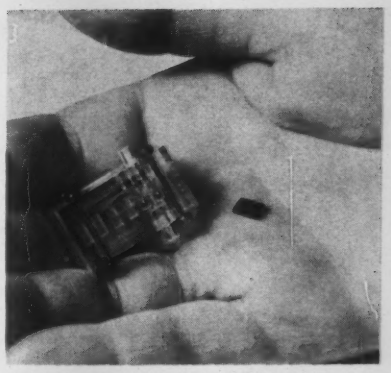


FIG. 3. **TRANSPARENT MODEL** has six flip-flops. Entire package (6 flip-flops) can be miniaturized into tiny black box shown on palm.

P_s (acting only on the area of the seat opening) tending to force the ball away from A, (2) the pressure (P — δ) in the cylinder (acting on the entire ball area) keeping the ball at A, and (3) a small pressure on the ball-area-less-the-seat-area due to the back pressure at 3, tending to force the ball away from A. The ball will remain at A as long as both side connections (3 and 4) are open.

If 3 is closed, pressure in the cylinder on both sides of the ball will equalize because of leakage between the ball and cylinder wall. The force acting on the seat area wil now move the ball away from A. As soon as the seal between the ball and seat A is broken, the supply pressure acts on the entire ball area, and the ball is driven rapidly to B. If the connection at 3 is now reopened, the ball will remain at B. Thus the momentary closure of 3 has caused the device to reverse its pressure and flow states. A momentary closure of 4 will cause the ball to return to A and remain there. The device, therefore, exhibits the properties of a true bistable element.

In Fig. 2 a pressure pulse applied at 3 while the ball is at A has the same effect as closing 3. However, actuation time is reduced because it no longer depends on leakage past the ball to bring the unit to the trigger point.

The output of the device can be taken as the pressure drop across the supply orifices (the orifices in this case are analogous to the load resistors in a vacuum-tube circuit).

The moving part in the pneumatic bistable element provides a direct means of converting between pneumatic and electric signals, simply by sensing the position of the moving part by means of a coil, or by capacitor plates or contacts embedded in the walls of the cylinder of the bistable element. The conversion from electric to pneumatic data is accomplished by forcing shuttle motion magnetically or electrostatically.

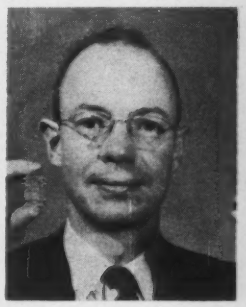
As the bistable element operates in terms of pressure *differentials*, it does not require highly accurate control of supply pressure, temperature, and leakage within the unit. No absolute seals are required. It is necessary only that certain inequalities in leakage areas have the right sense and approximate magnitude.

Construction and Packaging

The basic construction consists of a stack of five perforated and two solid plates. Matrix plates contain herringbone patterns of grooves in their two faces. Circuit connections are made simply by drilling through the matrix plates at the appropriate intersections of grooves.

Using the matrix plate method of construction, typical packaging densities, including power supply and interconnecting circuitry are 2,000 to 4,000 bistable elements per cubic inch (Fig. 3). A complete medium-size general-purpose digital computer, complete with matrix type memory, will occupy a slab approximately 5½″ square and 1″ thick. The small size of the orifices and passages used will require cleanliness of the gas supply equivalent to that obtained with three-micron filtering.

HUGH E. RIORDAN, has a Master's Degree in Mechanical Engineering from Rensselaer Polytechnic Institute. He has fourteen years experience in development of mechanical and electromechanical devices and systems for guidance and control, and holds several patents in these fields. Formerly with Applied Physics Lab, Johns Hopkins University, Curtiss Wright Corporation and Battelle Memorial Institute, Mr. Riordan is now Senior Staff Engineer at Kearfott. He is a a member of the Audio Engineering Society and the American Association for the Advancement of Science.



Linear Dead-weight Accelerometer Calibrator

Here is a simple technique for calibrating accelerometers using only known weights.

HERMAN PINSKY
Lockheed MSD
Van Nuys, Calif.

An apparatus for the purpose of calibrating linear accelerometers has been designed and built at Lockheed MSD, Van Nuys, and is currently in use. Any acceleration-sensing transducer (including strain gage, variable reluctance, potentiometric, and piezoelectric types) can be calibrated with this device.

The accelerometer is set up in a system of static equilibrium wherein the value of a total of three forces on the accelerometer is known accurately. When one of these forces is suddenly removed, the unbalanced forces that remain act on the accelerometer. The vector sum of the remaining forces, in combination with the mass of the accelerometer and its fixture, result in a condition of known acceleration in accordance with Newton's Second Law.

Typical vector forces of the equilibrium state are shown in Fig. 1, where force 1 is five times force 3, and force 1 equals force 2. They are arranged so that force 1 points 5.7° above horizontal. If force 2 were removed, forces 1 and 3 would remain with a resultant equal in magnitude to force 1 and having a direction of approximately 5.7° below the horizontal. With the sensitive axis of the accelerometer lying horizontally, the transducer then "sees" the horizontal components (cosine) of the resultant. This is about 99.6% of the full value of force 1. Misalignments of as much as 8.1° cause only a loss of 1% of the original desired value. As the ratio of force 1 to force 3 becomes greater, the loss due to misalignment becomes smaller.

This technique is useful because we are able to accurately determine forces 1 and 3 by measurement—that is, by weighing.

Force 3 is the weight of the accelerometer plus any type of gear attached to it. Force 1 is exactly equal to (W), a block of material that may be weighed or, better still, marked weights. The pulley (P) is rigidly fixed but free to rotate. The line from the weight (W), to the pulley, to the accelerometer, and to the rigid structure (R) is actually a light waxed string (20-lb breaking force, 0.086 gram/ft), and is secured to the structure (R).

Fig. 2 is the operational setup.

(C) is a clamp that will be closed on the string after system equilibrium is reached. It prevents the weights from falling. E is an elastic body (spring) whose main purpose is to slow the decay rate of Force 1 when Force 2 is removed. When (E) is stretched several inches initially, a later contraction of 0.004" (typical) is insignificant in regard to the lessening of the original force level. The elastic body may consist of steel springs, rubber bands, or other elastic material capable of being stretched at least twice its unstretched length. This elastic body does not determine the value of Force 1. The weights (W) set the upper limit and maintain repeatability of Force 1.

The screen (S) acts as an anti-damage device by catching the accelerometer in its course of motion.

A spring clamp (R) holds a small steel tab (t) against the force (W). The clamping force can be adjusted to accommodate any W.

The system is actuated when point (X) is struck a downward blow, causing the clamp jaws to open against the compression spring, thus releasing the tab. Force 2 is quickly removed.

From Newton's Second Law:

$$F = MA$$

where F = string tension provided by weights W or Force 1, M = mass value of accelerometer plus its harness; A = acceleration experienced by the accelerometer.

$$\text{Mass} = w/g$$

where w equals the accelerometer weight plus harness plus 2" of cable plus tab, all divided by g, (32.2 ft/sec²).

Thus $a = Fg/w$

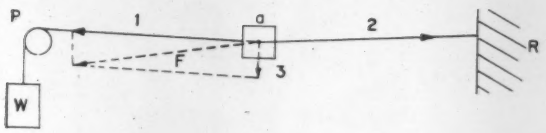


FIG. 1. PRINCIPLE of operation. Weight W and Force 3 causes resultant Force F to be acting on accelerometer when line to base R is suddenly cut.

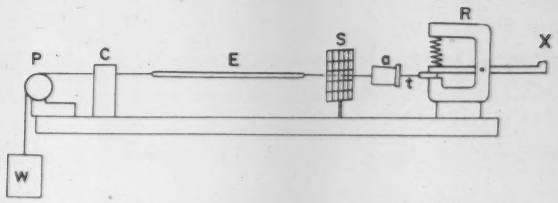


FIG. 2. OPERATIONAL setup.

Dividing both sides by g, the gravitational constant, to find acceleration in terms of that constant (G units):

$$a/g = G = Fg/wg = W/w$$

This states that the number of G's imposed on the accelerometer is equal to Force 1, or the value of the weights (W), divided by the weight of accelerometer plus its bracket or harness and the small steel tab. An electrical cable is also secured to the accelerometer and the weight of approximately 2 inches of it is added to (w).

The spring clamp mechanism (R) renders possible the removal of Force 2 in approximately 400 microseconds. The resulting voltage waveform of accelerometer output is such that at rest we have the zero output level; on actuation, output voltage rises rapidly to a plateau and then falls off at a rate dependent on accelerometer characteristics and associated electronic equipment. Records show that the amplitude in inches of the plateau is proportional to G's imposed. In this manner linear accelerometers of any type can be calibrated and linearity curves obtained. The fundamental references in the system are the values of the weights (W) and the accelerometer package (w), all obtainable on a weighing scale and easily determined to small fraction of grams or pounds.

It is of interest to note the distances traveled by a released accelerometer (removal of Force 2) under various G loads; these can be given in a table. The elapsed time will be taken as ½ millisecond for convenience. The relation

$$S = V_0t + \tfrac{1}{2}at^2$$

will be used where (S) is distance, V_0 is initial velocity, (t) is the time interval and (a) is acceleration which, although not constant, will be so regarded for the ½ millisecond period. The term V_0 is zero in this case.

G VALUE	DISTANCE TRAVELLED
10	0.0005"
20	0.001"
30	0.0014"
40	0.0019"
50	0.0024"
100	0.005"

The distances given are greater than the actual quantity by a small factor because of the small reduction of acceleration with elastic body contraction. As previously mentioned, the acceleration step function is impressed on the accelerometer within the first ½ millisecond after the tab is released from the spring clamp (R).

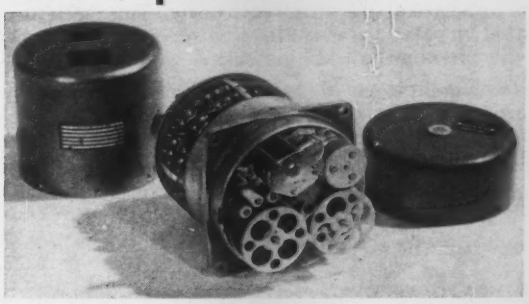
The apparatus described is for use in applications where a step-function type of calibration of accelerometers is desired. The fundamental references are of the simplest kind, namely, weight values, and the quality of the input conditions to the accelerometer is better than 99% of ideal. Calibrations of over 200 G's are possible on the existing prototype model. A heavier structure would make greater G values available.

In addition to the linearity parameter the calibrator yields information about three other variables—sensitivity, cross-axis sensitivity, and ringing frequency.

An analogous system for the rotational case appears to be possible. The fundamental relation here would be $M = I\, d\omega/dt$, where the force moment equals the product of the moment of inertia of the total rotatable mass (accelerometer plus additional necessary mechanism) and the angular acceleration.

Addition to our Magnetic Tape Review

Del Mar Engineering Laboratories offer a Model DS-500 magnetic tape programmer with multichannel precise timing functions. It provides contact closure at precise intervals over relatively long periods of time after actuation of "start time." It incorporates amplifiers and control circuitry for remote operation. The package contains two separate units—a tape transport section and an electronic section. Six-channel outputs in the programmer independently control six simultaneous functions. Timing accuracy is within 5 parts per million over a 15-minute program.



Measuring ranges	Compensator ranges	Max. limits of error
0-16.1 millivolt	0-1.1 millivolt	0.01 millivolt
0-16.1 millivolt	0-5.5 millivolt	0.02 millivolt
0-80.5 millivolt	0-1.1 or 0-5.5 millivolt	0.05 millivolt

Rubicon Model 2745 portable potentiometer. Price: $425, F.O.B., Philadelphia. Write for Specification Sheet RS 2745a.

This potentiometer has permanent accuracy*

It's possible to achieve impressively high potentiometer accuracy in one-shot tests under ideal laboratory conditions. And that is exactly how the advertised accuracies of some instruments are attained.

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A case in point is our Model 2745 portable potentiometer, shown above. Its exceptionally narrow limits of error will apply every time you use the instrument . . . today and years from now. Incidentally, this is the only portable potentiometer that extends reference junction compensation to the entire range of sub-zero measurements. It enables you to make a continuous series of measurements above and below the table reference temperature, without readjusting the compensator or reversing the leads. And its built-in Pointerlite galvanometer is sensitive enough to permit balancing to ± 0.002 millivolt in circuits up to 15 ohms.

This fine potentiometer and the entire Rubicon line of precision measuring instruments are available through Honeywell sales offices across the nation. MINNEAPOLIS-HONEYWELL, Ridge Avenue at 35th St., Philadelphia 32, Pa.

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CIRCLE 88 ON READER-SERVICE CARD

Self-Qualification of Laboratories

A. T. McPHERSON
Associate Director, National Bureau of Standards

HUNDREDS of new standards laboratories are being established in connection with weapons programs. Another group of standards laboratories is engaged in testing products for qualification or acceptance. Still another group is made up of laboratories of large industrial organizations which are concerned with the procurement of raw materials and the control of the quality of the finished product. The management of such laboratories needs some means of evaluating their performance.

Three major criteria determine the suitability of a laboratory for either product testing or calibration: (1) The qualifications of the supervisory and operating staff, (2) the facilities and equipment, and (3) the accuracy of the calibrations or tests performed as demonstrated by tests of reference samples. It is highly desirable to set up a general standard against which individual laboratories can measure their own qualifications for undertaking specific calibrations or test. The laboratories themselves, and not some independent agency, could do the rating, as follows:

Qualifications of Staff

The qualifications of *supervisory staff* could be rated in terms of academic training, length and level of professional experience, and publications and other evidence of scientific or technical accomplishment. The qualifications of the *supporting staff* could be demonstrated similarly in terms of training and experience. The terms of employment would also be significant.

Facilities and Equipment

Calibrations require standards of appropriate accuracy, and these standards should be related through the minimum number of stages to the national standards. This would probably be the easiest of the three criteria to evaluate accurately because most laboratories take pride in showing their plant and equipment.

Reference-Sample Tests and Calibrations

The actual performance of a laboratory as demonstrated by the testing or calibration of "unknown" reference samples consisting of either materials or test specimens would be the most critical measure of its capability of performing work in a given area. A reference-sample program, to be practical, would require a central organization and a sufficient number of participating laboratories to keep the expense within reasonable limits.

The central organization would prepare suitable specimens of undisclosed composition, dimension, or other pertinent characteristics, and would distribute them at intervals to participating laboratories. The laboratories in the program would make the requisite tests, measurements, or calibrations, and report the results to the central organization by a specified date. At that time, the central organization would send to each laboratory the correct value and the limits within which the results should fall if the work were done with reasonable skill and competence. The laboratory, not the central agency, would release the results in a *qualification report.*

The cost of preparing the specimens would be defrayed by the participating laboratories on an annual basis to insure continuity of the program.

The selection of reference specimens should be such as to require the use of methods and techniques characteristic of the area in which qualification is desired.

Report of Qualifications

The report of qualifications would be presented on a standard form drawn up to give the essential information about laboratory staff, facilities and equipment, and performance in the examination of reference specimens. Each laboratory would prepare and issue its own report and would be obligated to furnish proof of any statement that might be questioned.

Central Agency for Qualification

Inasmuch as the qualification plan is intended to be operated on a voluntary basis, it is important that it be conducted by private initiative rather than by a government agency.

The management of a central agency established to implement the plan might be vested in a group made up of representatives of (1) the laboratories to be evaluated ,(2) those using the services of these laboratories together with (3) independent, disinterested scientific experts. This group might be organized under the auspices of a recognized national standardizing society or association.

Hitherto, national societies have avoided activities pertaining to the evaluation of laboratories because they did not wish to be concerned with subjective judgments or with the approval or disapproval of individual laboratories. However, they might be responsive to the present plan because under the plan the central agency would be responsible only for administering the operation, and collecting and collating factual information in accordance with recognized standard procedures. The only public release of the results of the evaluation of any laboratory would be made by the laboratory itself.

Cost of Operation

The cost of the operation would be defrayed by the sale of the reference specimens, inasmuch as the major item of expense would be their preparation and distribution. The principal sale of reference specimens would be to the laboratories on an annual subscription basis, but they would also be available to any users of laboratory services who might wish to make further tests of the performance of particular laboratories.

Abstracted from ASTM Bulletin, May, 1960.

JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION

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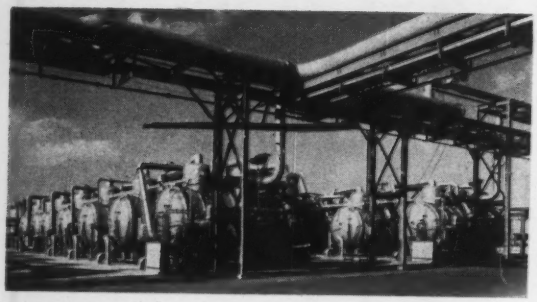


FIG. 1. SALINE evaporators at Aruba conversion plant.

Fresh Water from the Sea

C. R. TOWNSEND
The Fluor Corp., Ltd.

As new supplies of natural water become more costly, saline water conversion becomes more important as a solution to water shortage.

C. R. TOWNSEND is a research engineer at The Fluor Corporation, Ltd. He obtained a B.S. degree in chemical engineering from Oregon State College in 1956. In that year, he joined Fluor's Research Division, and has since worked on economic evaluations and design studies of saline water conversion processes for the State and Federal governments.

SCMA August Meeting Notice

Date: Thursday, August 17th

Place: Rio Hondo Country Club, Downey, Calif. Dinner 6:30 P. M.; Meeting 8:00 P. M.

Subject: Mohole Project—Experimental Drilling Program

Speaker: Russell B. Thornburg, Project Manager, Global Marine Exploration Co.

SEA-WATER CONVERSION produces fresh, drinkable water from sea water either by removing the salt (leaving salt and fresh water) or by removing a portion of the water (leaving fresh water and a more-concentrated sea water, or brine).

From a scientific standpoint, separating fresh water from sea water is not difficult. Many processes have been known, and were demonstrated, many years ago; a few processes are of more-recent origin. In 1790, Thomas Jefferson outlined a method for distilling sea water on board ships. A still that used heat from the sun to evaporate salt water was built in the Andes mountains in Chile in 1883 to provide water for a mining camp.

In modern times, several sea-water conversion plants have been built in remote areas that have little or no natural-water supplies. The largest of these plants was built on the Island of Aruba in the Dutch West Indies. This plant is the only water supply for the 55,000 inhabitants of the island (Fig. 1). Other large sea-water conversion plants have been built at Kuwait, on the Persian Gulf, to supply the tiny oil-producing country with water.

Here in the United States, sea-water conversion is being used at the Morro Bay Steam Electric Power Plant in California for its huge steam boilers.

Recently, the city of Coalinga, on the western edge of the San Joaquin Valley oil-producing area, installed a plant to convert their brackish water (salty well water) into drinkable water. This plant uses *electrodialysis* to remove the salt from the water.

Conversion Processes

Processes include (1) various distillation techniques, (2) freezing, (3) solvent extraction, (4) ion-exchange, and (5) membrane processes.

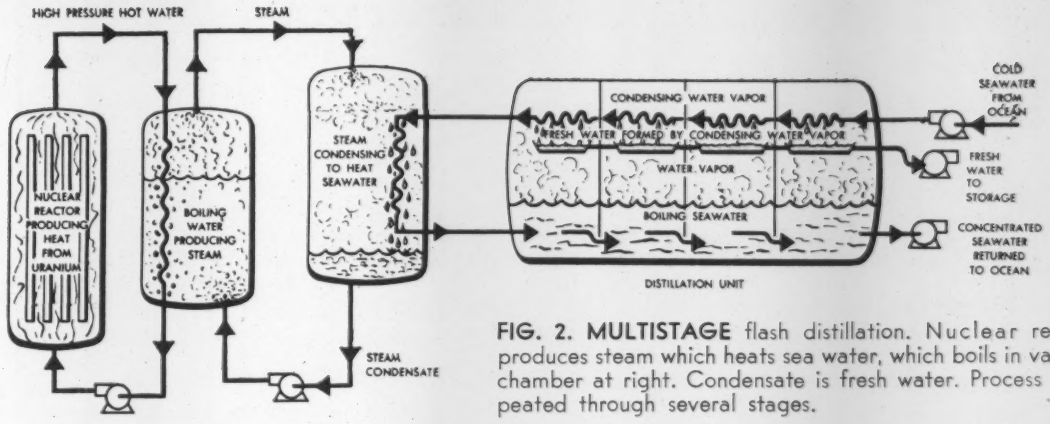


FIG. 2. MULTISTAGE flash distillation. Nuclear reactor produces steam which heats sea water, which boils in vacuum chamber at right. Condensate is fresh water. Process is repeated through several stages.

Multiple-effect distillation boils sea water. The steam is piped to a second evaporator and used to boil more sea water. In doing this, it condenses to form fresh water. The steam formed in the second evaporator is used again in the same manner to form more fresh water; the original supply of heat is used several times. The steam that is formed in each evaporator is condensed in the next to become fresh water. Each progressive reuse of the heat is called an "effect." A variation of this distillation is called "multistage flash distillation."

Another distillation method, *solar distillation*, uses heat from the sun to evaporate sea water under a glass or plastic cover. Evaporated water vapor condenses on the bottom of the glass or plastic cover and is drained into a collector. However, to supply the water needs of Southern California with a solar still would require a heat collector covering an area of about 400 square miles.

Freezing works on the principle that ice crystals frozen from a salt solution will be composed of pure water, while the salt remains in the unfrozen portion of the solution. Freezing is one of the more promising processes now under development, but there are many problems to be solved, such as the removal of salt water that has been trapped by the ice crystals.

In *solvent extraction*, water is absorbed from sea water by a solvent which will not mix with the salty water. Absorbed water can be removed from the solvent by various means, such as changing the temperature of the solvent. Solvent extraction processes are, at present, in the development stage with many problems yet to be solved.

In *ion-exchange*, the salt is chemically removed from the sea water. Sea water is passed through solid chemicals, which remove the salt from the water much the same as a home water softener removes minerals. In the present state of development, the cost of the chemicals used makes this process impractical.

The *membrane* processes use thin films of plastic or other material which will allow the components of salt to pass through microscopic pores, but which will block the flow of water, thus reducing the concentration of salt in the sea water. The most promising membrane process, called *electrodialysis*, uses an electric current to force the salt through the membrane.

It has been proved that all of these methods are technically feasible. Many of them have been developed to a point where they are practical sources of fresh water for many areas that are without an adequate source of natural water. The big problem has been quantity production at a cost competitive with the cost of water from natural sources.

Economics of Multistage Flash

As part of the work done for the Office of Saline Water, Fluor made a preliminary design and detailed cost analysis of multistage flash distillation. This was for a San Diego plant with a production capacity of one million gallons of fresh water per day, and for a proposed plant with a capacity of 50 million gallons per day for any seacoast site in Southern California.

Since a large plant can produce water at a lower cost than a small plant, it was necessary to determine the cost of the 50-million-gallon-per-day plant to find the lowest price of converted water. In this plant the water would be distilled in a dozen large vessels, approximately 30′ in diameter and 140′ long. (Fig. 3). A plant of this size would fulfill the water need of approximately 250,000 persons.

The reactor vessel (112′ x 140′ high) can produce low-pressure steam for heating at a lower cost than either a gas- or oil-fired boiler. The low operating pressure permits the reactor to be built of lighter and less-expensive materials than are needed in a nuclear reactor designed to provide the high-pressure steam necessary for generating electric power.

The total cost for this plant would be $42.2 million. The distillation part of the plant represents $30.7 million, while the reactor would cost $11.5 million. The cost of the water produced by this plant would be approximately 42 cents per thousand gallons ($136 per acre foot), including all operating and maintenance cost plus amortization of the capital cost of the plant.

The one-million-gallon-per-day plant is similar to the larger plant.

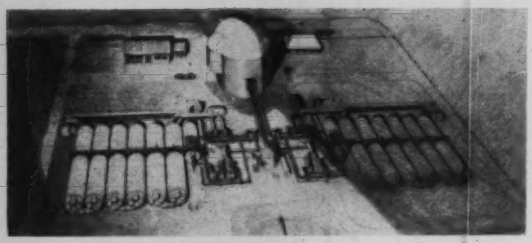


FIG. 3. FIFTY-MILLION-gallon-per-day sea-water conversion plant.

Economics of Other Processes

The other processes described have been analyzed economically by various research and engineering companies (Table 1). In general, distillation processes can produce water at lower cost than natural sources in many arid areas. Solvent extraction and ion-exchange processes cannot compete economically with the other processes at this time. Freezing shows some promise for the near future. The membrane processes convert sea water to fresh water at a cost which is still high, although they convert brackish water at competitive costs.

At present, natural fresh water costs the consumer between 20 and 60 cents per thousand gallons in most areas of this country, and more in remote arid locations. The point at which converting sea water becomes more economical than developing natural supplies will depend on the particular local situation. For many areas, sea-water conversion will never be practical, while in other areas it is much cheaper than natural supplies at the present time.

TABLE 1—COSTS OF CONVERTED WATER

PROCESS	CENTS PER THOUSAND GALLONS*
Distillation	
Multistage Flash	42
Multiple Effect	50-100
Vapor Compression	70-100
Solar Heat	100-200
Freezing	40-140
Membrane	
(Electrodialysis) sea water	60-200
brackish water	30-100
Solvent Extraction	140-200
Ion-Exchange	200-1000

*Depends on plant capacity

Strain-Gage Temperature Compensation

LEON J. WEYMOUTH
Baldwin-Lima-Hamilton Corp.

CONVENTIONAL temperature-compensated strain gages have been "custom-made" for use on only one specific material over a rather short temperature range. The SR-4 Foil Strain Gage Types* FNH and FNB (Fig. 1) provide automatic self-temperature compensation. The temperature characteristic can be adjusted externally by the typical circuit shown in Fig. 2. The three-wire lead virtually eliminates the effect of temperature on the lead-wire system.

This system employs the conventional three-wire lead used in the standard "active-dummy" gage circuit. An adjustable resistor (R_B in Fig 2) is in series with the low-resistance platinum temperature-sensing element. The R_B resistance value can be adjusted so that the percentage change in resistance of the platinum element exactly cancels the percentage change in resistance of the Nichrome V strain-sensing element at a particular temperature on a specific test material. The R_B value also can be adjusted to minimize temperature effect on gage response over a given operating temperature range.

Fig. 3 shows temperature response characteristics of a type FNB in the cryogenic temperature range.

*Patent Nos. 2,292,549 and 2,672,048

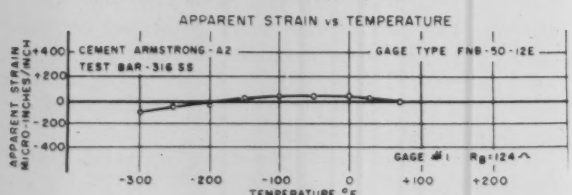


FIG. 3 Typical response.

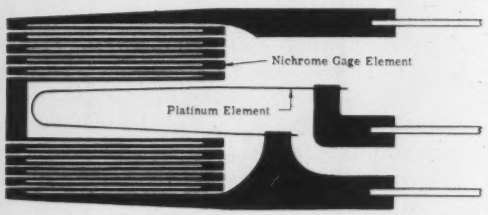


FIG. 1. FOIL strain gage with integral platinum thermal compensation.

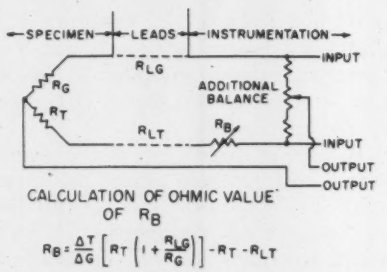
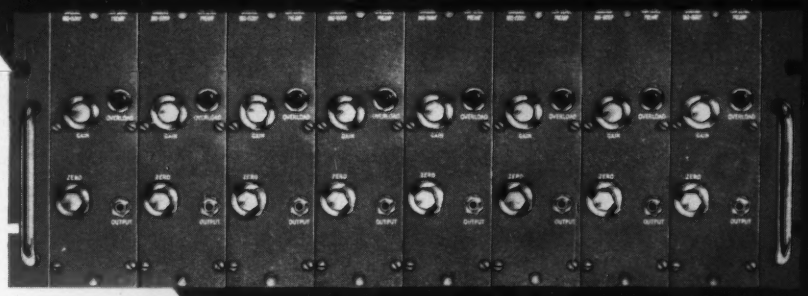


FIG. 2. TYPICAL installation circuitry, RT is resistance of compensating element; RG is resistance of active element. RLT is total resistance of compensating arm lead wire; RLG is total resistance of the active arm lead wire; ΔT is change in resistance per unit change of temperature of the compensating element (on a particular material); ΔG is change in resistance per unit change of temperature of the active gage element (on the same material used to determine ΔT). $\Delta T/\Delta G$ is ratio used in the calculation of R_B.

Model 860-1500P — handles low level DC data signals in the presence of high common mode



Model 658-3400 — drives high frequency optical galvanometers to 5 KC

COMPACT 7" HIGH 8-CHANNEL UNITS ARE COMPLETELY TRANSISTORIZED, HAVE FLOATING INPUT ISOLATED FROM OUTPUT

Sanborn precision amplifiers

▼ Data Preamplifier — Model 860-1500P

Designed for precise, economical amplification of signals with source impedance of zero to 10,000 ohms, such as thermocouples, strain gage bridges, etc. in presence of severe ground loop noise, and for driving digital voltmeters, scopes, tape recorders and similar devices. Each plug-in unit is only 2" x 7" x 14½" deep; 64 channels with blower require only 60" of rack-panel space. Separate 868-500 Power Supply required for every 8 preamplifiers. Power consumption 2.5 watts per channel.

Noise	3 uv peak-to-peak
Gain	100 (10 mv in gives 1 v out) (Model 860-1500PA with gain of 1000 also available)
Output	± 1 v across 300 ohms, DC-70 cps; ± 1.5 v to 40 cps. Output impedance 100 ohms. (10 v across 10K available on special order.)
Linearity	± 0.1% of full scale output (2 v)
Common Mode Performance	120 db rejection at 60 cps, 160 db at DC, with 5000 ohms unbalance in source. Inphase tolerance 220VAC.
Input Impedance	Greater than 200,000 ohms
Gain Stability	± 0.1% for 24 hours
Drift	± 2 uv referred to input
Rise Time	to 99.9% less than 25 ms

▼ Optical Galvanometer Amplifier — Model 658-3400

Eight channels of amplification and common power supply. Each channel provides for sensitivity, compensation, damping and current limiting. Inputs floating and guarded, impedance 100,000 ohms on all ranges. All amplifier elements except output transistors are plug-in assemblies.

Sensitivity	± 10 mv input gives ± 400 ma output into 20 ohm load (max.). Eleven attenuator steps to X2000 in 1-2-5 ratio, smooth gain control.
Common Mode Performance	± 500 volts, max; rejection 140 db min at DC.
Gain Stability	Better than 1% to 50°C and for line voltage variation from 103-127 volts.
Frequency Response	0 to 5 KC within 3 db; can accomodate wide range of galvanometers.
Output	Output networks available for wide range of galvanometers.
Power Consumption	125 watts for 8 channels.

Your Sanborn Sales-Engineering Representative (offices throughout the U. S., Canada and overseas) will provide detailed information and application assistance. Call him or write plant in Waltham, Mass.

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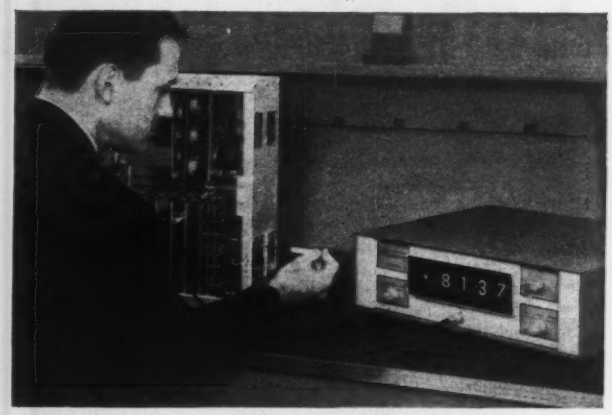

Write for complete details on the new Electronic Associates, Inc. Series 5000 Voltmeters, or call your nearest EAI Engineering Representative.

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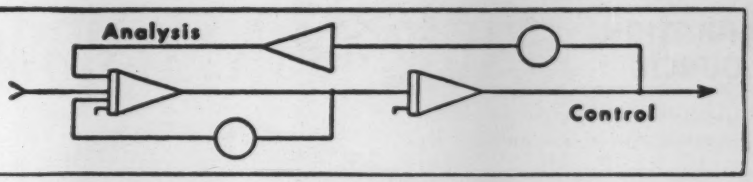

Newsletter

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Bits

This month's Pieces is aptly named—it consists of pieces of talks from two meetings partially covered in last month's *Newsletter*. They are the Western Simulation Council meeting of 12 January on "Digital Simulation of Large-Scale Man-Machine Systems" and the Eastern Simulation Council meeting of 20 February on "Simulation in a Digital Computer Company."

That, along with our new Analog Techniques column, SCI Activities, some Info, and a couple of letters, makes quite enough *Newsletter* for this month!

Pieces

WESTERN S/C MEETING AT SDC; 12 JANUARY, CONCLUDED

Stanley Rothman, Head, Space Systems Branch (System Development Corp., Santa Monica, Calif.) has sent us "all but one of the speeches given at the January Western Simulation Council meeting, edited and printed for publication in your *Newsletter*."

Included are "Effectiveness Studies of Manned Airborne Weapon Systems by Digital Simulation," **P. H. Kennard;** "Tour of the Q-7 SAGE Facility," **S. Zasloff;** "Tour of the Automated Teaching Facility," **H. F. Silberman;** and "An Experiment on Decision-Making in a Complex Environment," **R. J. Meeker.**

Last month we published abstracts of some of the other talks, and our condensations of the rest follow. We are sorry that we cannot include these talks in toto as prepared for us by Mr. Rothman, but if we attempted to publish all of the complete talks made available to us from the various Councils we would have a book each month, instead of a *Newsletter*. This would be contrary to our objective: in the *Newsletter* we only try to let you know who, where, is doing what, and tell those who are interested where they can get more details, in this case, from **Stanley Rothman,** System Development Corp., 2500 Colorado Avenue, Santa Monica, Calif.

Complete papers (if they can survive a rather rigorous refereeing system) will henceforth be published in IRETEC (Institute of Radio Engineers Transactions on Electronic Computers). For more details, see Info.

Effectiveness Studies of Manned Airborne Weapon Systems by Digital Simulation

P. H. Kennard (Hughes Aircraft Co., Culver City, Calif.)

Measures of effectiveness of airborne weapon systems have two principal applications: 1) as a design aid in determining optimum hardware parameters during the development of a system, and 2) to assist in determining tactical recommendations for the military forces on the most effective means of using a weapon system.

The effectiveness of a manned interceptor attack on a single bomber is conveniently described by the following equation:

$$P_s = P_i P_{dc} P_k$$

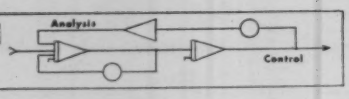
where, P_s = over-all probability of success,

P_i = probability of intercept, i.e., probability that the ground control environment will succeed in vectoring the interceptor into position for the terminal attack phase,

P_{dc} = probability of airborne radar detection and conversion by the interceptor to an acceptable armament launch position,

P_k = probability of bomber kill by the armament.

It is apparent from the above relationship that the product $P_{dc}P_k$ is directly attributable to the airborne weapon-system effectiveness; which



is typically defined by the probability of detection, conversion and kill P_{dck} (i.e., $P_{dck} = (P_{dc})(P_{k/dc})$, where $P_{k/dc}$ is the conditional probability of kill).

To evaluate interceptor weapon systems effectiveness in terms of P_{dck}, a series of digital simulation models at Hughes Aircraft Co. has been developed. The basic model, called SMITE (Simulation Model of Interceptor Terminal Effectiveness), represents the final attack phase of a single interceptor-bomber engagement. Monte Carlo techniques are employed with the IBM 7090 computer to evaluate P_{dck} from random sampling representations of vectoring dispersions, single scan probabilities of radar detection, lock-on delays, and countermeasures effects. Simplified flight control and fire-control steering equations govern the conversion from detection to firing positions. Armament kill probability computations are performed based on launch geometry. Digital simulation was chosen for its speed, convenience in handling random sampling, and relative ease with which the model can be entered and removed from the computer. Nominal running time for 100 trials (one case) on the IBM 7090 is approximately 25 seconds. Storage requirements are moderate, requiring about 4,000 of the 32,000 available spaces.

In addition to the measures of effectiveness, a considerable amount of information on system performance is obtained from the model. The causes of failures are identified, radar detection and lock-on ranges are computed for the mean and 85% cumulative probability values, combat time distribution is indicated, and several special printouts are available at the operator's discretion.

Once the utility of the basic SMITE model had been demonstrated at Hughes in 1957, there followed a series of modifications and improvements which have been incorporated in other models. The salient characteristics of some of these models are:

IMPROVEMENTS TO BASIC SMITE PROGRAM

- Sampling representation of countermeasures effects with interceptor countertactics.
- Provision for target maneuver.
- Optional initial conditions before offset.
- Pursuit course model.
- Auxiliary ranging model.
- Pulse doppler radar model.
- English language instructions to the IBM 709 and compiler programming techniques.

* * *

In connection with the exceptionally interesting tour of the SDC facilities, there were a couple of introductory talks. One was the

Introduction to Tour of the Q-7 (SAGE) Facility

S. Zasloff (SDC)

"The word 'sage' normally means wise," said Mr. Zasloff. "However, in the case of the SAGE computer system, it is an acronym for Semi-Automatic Ground Environment. I mention this only to make the point that things are not always what they appear to be. This, of course, is the very essence of simulation itself."

The SAGE computer system is a network of some 30 duplexed, high-speed, digital computers scattered around the country. Each duplexed set of computers handles the air defense mission for a given area or sector of the country. All the radar sets in each sector are connected to the computers, which process radar data as they come in. In effect, the computers act as an automated plotting board for the data. Tactical decisions for air defense are made by Air Force personnel, who monitor the display consoles fed by the computer.

In addition to these 30 sets of duplexed computers around the country, SDC has an extra set of duplexed SAGE computers in Santa Monica. These are used to check out the master air defense program as a pure production tool, with no live radar inputs of any kind. The problem in checking out the SAGE program lies in telling whether the Air Defense program is doing what it's supposed to be doing when it has no live data to work on. Three kinds of simulation are used to check.

To simulate radar, computer programs take punched-card inputs prepared by test personnel and convert this into radar-like data stored on magnetic tape. As the air-defense program cycles, the simulated data are fed in from tape and the computer program reacts to it as if it were actually undergoing a real-life stress situation.

SDC also makes use of keyboard simulation. One part of the SAGE system is a battery of consoles which have large display scopes somewhat like television consoles. The SAGE computer displays on these consoles pictures which show the Air Force personnel what air traffic looks like in the sector. In response to the displays, the Air Force personnel may press keyboard buttons making requests for information from or for actions by the computer, or giving certain kinds of information to the computer.

Simulation actually accomplishes the functions needed directly and under closely controlled situations. If live radar data were used, there would be no way of controlling precisely how an aircraft would fly. With simulated date, they know exactly where the plane is going and the value of each parameter in the system.

They also use table simulation. For example, if they were running a test of the air defense situation and wanted to see how the master air defense program was reacting under a given set of circumstances, they would load the various data tables in the system with a set of initial parameters which simulate the situation desired and then would cycle the master air defense program. The manner in which the master program reacted to the initial data would give clues as to how it would react to similar situations in a real-life environment.

Silberman on Automated Teaching

H. Silberman gave the introduction to the tour of the Automated Teaching Facility, a company-sponsored research project started in 1958 which has produced a computer-based teaching machine.

Mr. Silberman explained that a teaching machine is not an automaton which is going to go in and replace teachers. In fact the machine doesn't teach at all. It's the materials that are programmed for the machine which do the teaching. Actually, automated teaching is a method or a set of principles which are incorporated in the design of a machine.

The first principle is that the subject matter to be taught is broken out into a series of small steps. The student gradually progresses through these steps from where he is to where you want him to be when he finishes the lesson.

The second principle is that the student actively participates in the lesson. This is effected by having each step designed in the form of a question. This requires the student's attention at each step along the route. Socrates used this method about 400 B.C.

The third principle is that clues are supplied within these teaching items which help the student answer each item correctly. This support is

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J. E. Sherman, Analog Computer Manager, of Lockheed's Missiles and Space Division's EASE® Analog Computer Installation. The Lockheed Analog Computer Installation is one of the largest in the world.

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Lockheed Missiles and Space Division, Sunnyvale, California, leading research and development organization, beat its own schedule by three years and surpassed its own performance goals by wide margins to provide the Free World with the most important operational deterent to aggression: the Navy's POLARIS Fleet Ballistic Missile. • Lockheed has actually just crossed the threshold of space and defense programs. Future development of Polaris and other Lockheed space and missile programs will be more complex, intricate and demanding—will require research computation of a level and complexity never even envisioned. The problem-solving capacity of Beckman EASE Analog Computers meets this challenge.

LOCKHEED-EASE History EASE Analog Computers have participated in Lockheed success for over 5 years at the Lockheed-Georgia Division where the new Jet-Star executive jet transports and C-130 Hercules are manufactured and for over 2 years at Lockheed-California Division, famous for the Air Force F104 Interceptor and Navy P3VI Electra.

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gradually faded out to wean the student from the machine before he completes the lesson.

The fourth principle is that immediate knowledge of results is supplied to the student. He knows how he's doing!

And the fifth principle is that examples are used for describing any principles which are to be taught. This helps the student to develop a real understanding that he can transfer to novel problem situations later.

A sixth principle, which can be added if one wishes to go into a more complex form, is the adaptation of instruction to individual differences among students. Most of the simpler devices incorporate the first five principles, but it takes something like a computer to really use this sixth principle of modifying the instruction to fit the needs of the student.*

SDC plans to expand its teaching facility. It will be about the same type of operation as the present facility, but will be multiplexed to include as many as 20 stations. Actually the size of the computer (Philco 2000) would allow them to tie 100 or more student stations into the one central control unit. The larger class facility will also be used for studying educational problems within a system context. Instructional counseling and administrative-type, problem-solving functions will be integrated into the central control program.

Meeker on "Decision Making"

R. J. Meeker (SDC) had some interesting observations concerning "An Experiment on Decision-making in a Complex Environment."

"Our study," he said, "Is one of human decision-making in a complex environment. The phrase '*human* decision-making' can be regarded as something of a redundancy, but it should serve to contrast a psychological study from others. The complex environment which we have chosen to simulate in the laboratory is that of a SAGE sector battle staff."

The SAGE sector battle staff is composed of seven to nine members; it is the staff echelon closest to any tactical situation in the Air Defense Command; it is the group responsible for the conduct of air defense in a specified portion of the United States. In the SDC simulated environment there are three battle staff members: a sector commander, a fighter officer for missiles, and a fighter officer for interceptors. The subjects receive essentially the same input information as the battle staff actually does. This is accomplished through the use of a closed-circuit TV system, a telephone system and written messages.

It was assumed that there is a directive or SOP (Standard Operating Procedure) or regulation to cover every situation that battle staff members could conceivably encounter. But military doctrines are generally written with less than the completeness and consistency of a postulate set in geometry, so this assumption was bound to be incorrect in a number of instances.

The result of the analysis is a simple flow diagram reflecting the procedures which battle staffs would employ according to regulation. However, at certain junctures in these procedural programs the sequence of neatly ordered steps in the routine is broken; no procedure unequivocally applies to the situation, and we have identified a decision situation.

Associated with each such situation is a characteristic set of alternatives, but there is no super-ordinate rule which permits unequivocal selection from among the possible courses of action.

Mr. Meeker told of constructing situations which incorporate given configurations of alternatives in terms of situation types, with the alternatives classified as good, poor, mixed, bland, or uncertain.

Mechanical recordings were made whenever the subject was required to select or request information; tape recordings were made of the subjects' "thinking out loud." Also, each subject was monitored by an observer. Whenever the "thinking out loud" needed to be supplemented or required clarification, the observer requested the subject to give a fuller verbal response to the situation. These recorded responses and records of computer information constitute the behavior patterns which will be matched against the decision situations created for the subjects. SDC will then compare the behavior predicted by their model of decision-making with that actually called forth.

*We were interested to hear something of the students who have taken instruction from the SDC machines. They have been at the high-school level and have ranged from the very bright to the awfully dull. A boy with IQ in the 70's was mentioned as having taken four hours to do what others romped through in 20 minutes. But—and were impressed by this—he definitely did learn something in his automated lesson.—Ed.

EASTERN S/C MEETING OF 20 FEB AT IBM CONCLUDED

Last month we presented one of the papers from **Bill Blodgett's** report on the Eastern Simulation Council's meeting of 20 February at IBM in Kingston, New York, almost in its entirety: "Circuit Simulation by a Direct Approach" by **Boucher** and **Lecher.**

This month we complete our report on the Kingston meeting, with the following abstracts, condensations, and comments.

A Preliminary Study of Fixed-Bed Tubular Catalytic Reactor Dynamics on an Analog Computer

H. D. Yoo
IBM Research
Yorktown Heights, N. Y.

During the last ten years many papers have been published on chemical reactor simulation. Most of these papers deal with single stirred-pot reactors, or with highly theoretical studies, or just serve to satisfy one's curiosity to try out "maybe" a new computer simulation method. But often people neglect to examine their own approach by looking at the problem objectively, considering the computer simulation techniques involved, the difficulty of describing the physical system behavior mathematically, and the justification of the simulation study itself.

A case study was presented of analog simulation of a fixed-bed tubular catalytic reactor in which exothermic reaction takes place. The gas composition and the temperature in the tube vary with time and location, and generated heat is continuously removed at the wall. The primary objectives of the study were: (a) to examine the complexity of the problem, and (b) to get a quick idea as to how long the dynamic period is. By making a series of assumptions, a 5-cell stirred-pot analog model was developed. From the simulation of the system a 15-minute dynamic period was observed. By adding an error-rate control to the system, some interesting improvements were demonstrated in altering the transient response path of the process to both stable and unstable systems.

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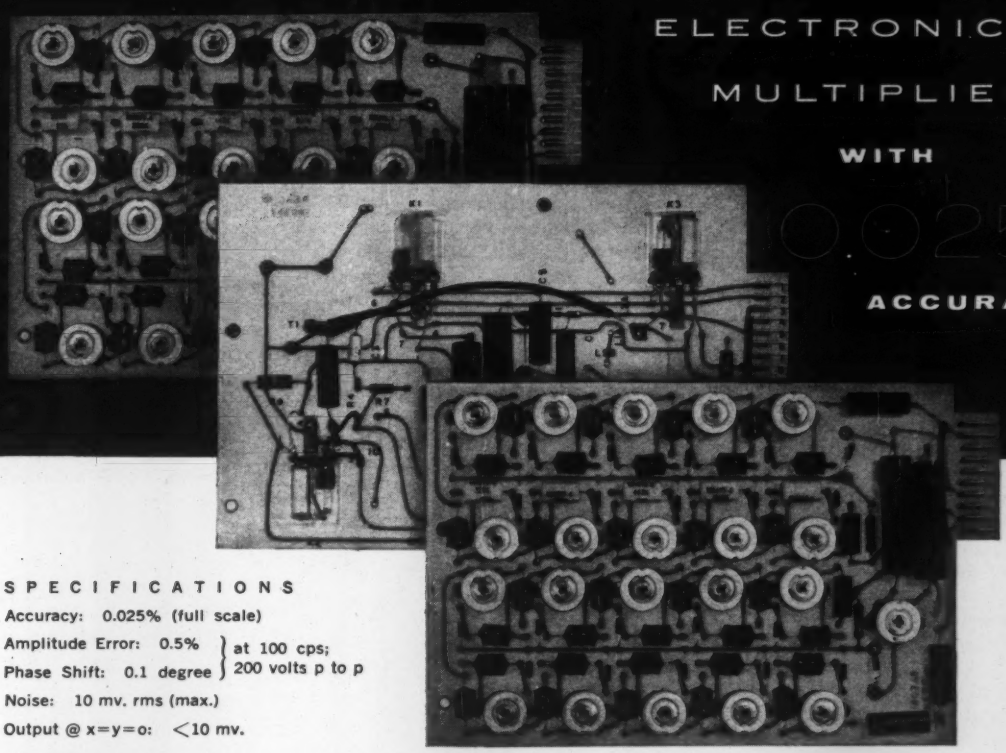

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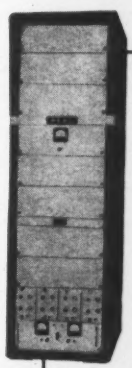

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can be seen from the results. There is considerable question whether it pays to construct complex models when the data are poor, our ability to describe the process characteristics is limited, and the computer simulation is involved. Careful examination of the simulation approach must be made in each case.

Computational Machine Analysis of the Transient Response of Nonlinear Circuits

P. A. Honkanen

To incorporate new circuits into logical blocks or larger circuit, the response of the circuit must be known to a predetermined degree of accuracy. The transient response is particularly important in modern fast circuits. This response can be obtained either by actual circuit measurements (bench-test) or by analytical analysis.

The former method gives a certain feeling of security since the actual circuit is measured for its response; but besides being costly (in both time and money) it has the disadvantage that a physical circuit must be first constructed and then reconstructed if any of the circuit elements are to be varied. Also, to avoid disaster, most bench-test analyses are performed on a "worst case" design basis and this requires much more from the circuit than is needed.

The alternative approach is to analyse the circuit by means of a mathematical analog of the circuit. This approach presents two questions that must be answered; first, how shall the analysis be performed? and second, how valid is the mathematical analogy as a true representation of the physical device? The analysis can be carried out by any one of the following methods: (1) by hand using many approximations; (2) by using an analog computer; and (3) by using a general program written for a digital computer, that is, one that will require only the representation of the circuit in symbolic and/or numeric form as input data. Success of methods (2) and (3) depends on the validity of the mathematical analog. Representing physical devices like transistors and diodes presents problems.

In considering which type of computer to use, one must weigh the advantages and disadvantages of each. Clearly the main advantage of the analog computer is that the solution can be in real time, or machine running time can be reduced by exchanging time for accuracy. Another advantage is that the circuit parameters are represented by the physical elements of the computer; this permits easy variation of parameters. In addition, high-speed repetitive display systems permit shaping of responses and thus enable us to determine how changes in various parameters affect the circuit operation in a relatively short time. We can also quickly determine correct circuit component values.

The main disadvantage of the analog system as a tool of circuit analysis is that it is restricted to single-circuit analyses; each circuit must be treated as a separate problem. Each time, the equations describing the circuit must be written,* from these the block diagram is drawn, and finally the computer board is wired to connect the various components.

The main advantage of a digital computer program is that it is easy to use. Once the general program is written, the only remaining thing to do is to represent the circuit topology by means of numeric or symbolic input data. The main obstacle here is that the general program has to be written. A start in this direction is the program PECANS for the IBM 704 or the IBM 7090. (This program described in some detail by the author, will not be covered here.)

Some of the disadvantages of the digital program solution are that the whole circuit must be rerun for any change in parameter values and, at present, the actual machine time tends to be long in some cases. (However, a new technique has been developed which, when incorporated into the program, is expected to decrease the machine time by a factor of up to 100.) Another disadvantage is that any peculiar relationships in the circuit might require additional programming.

Because the analog computer solution to the transient analysis problem is not general but specific for each circuit, not much can be said without referring to specific circuits. One method that bears mentioning is that

*No! See Boucher and Lecher last month—and this same author later.—Ed.

PENTTI A. HONKANEN graduated from the University of Colorado in 1959 with a B. S. degree in Electrical Engineering and a B. S. degree in Applied Mathematics. He joined the Development Laboratory, Data Systems Division of International Business Machines Corporation in September 1959. He has been in the Scientific Computation Department since that time, engaged primarily in various aspects of circuit analysis. He is a member of the American Institute of Electrical Engineers and Tau Beta Pi, Eta Kappa Nu and Sigma Tau engineering honor societies.

of forming the block diagram for computer elements directly from the circuit schematic diagram, thus avoiding the necessity of writing the differential equations. This method can be illustrated best by means of a simple circuit. Consider the circuit of Fig. 1 with reference direction established as positive in the direction of the arrow.

Since integration is a much more stable process than differentiation, it is best to write all the equations in integral form. Thus, the voltage and current equations for the circuit elements are as follows:

Inductor:

$$i = \int \frac{V\,dt}{L}$$

Capacitor:

$$V = \int \frac{i\,dt}{C}$$

Resistor:

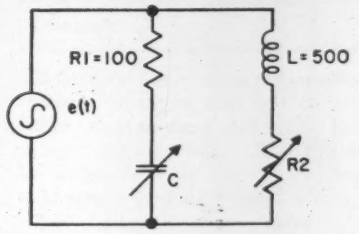
$$i = V/R$$

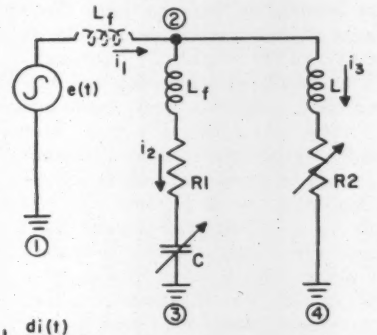
With the above relationships in mind one can proceed to analyze the circuit of Figure 2.

Assume V_{in} and V_{R1} are known. Then the summation amplifier 1 will have V_L as an output. This represents the voltage equation:

$$V_L + V_{R1} - V_{in} = 0$$

If V_L is multiplied by 1/L, then integrated, the result will be i_L (in-





$$L\frac{di(t)}{dt} = e(t) - i(t)\,R(i,v) - \frac{1}{C(i,v)}\int_0^t i(t)\,dt$$

$$e(t) = L_f\,di_1/dt + L_f\,di_2/dt + i_2 R1 + \frac{1}{c}\int i_2\,dt$$

$$e(t) = L_f\,di_1/dt + L\,di_3/dt + R_2 i_3$$

$$i_1 = i_2 + i_3$$

$$\begin{bmatrix} L_f & L_f & 0 \\ L_f & 0 & L \\ 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} \dot{I}_1 \\ \dot{I}_2 \\ \dot{I}_3 \end{bmatrix} = \begin{bmatrix} e(t) - i_2 R1 - \frac{1}{c}\int i_2\,dt \\ e(t) - i_3 R2 \\ 0 \end{bmatrix}$$

$$[\dot{I}] = [L]^{-1}[B]$$

FIG. 1

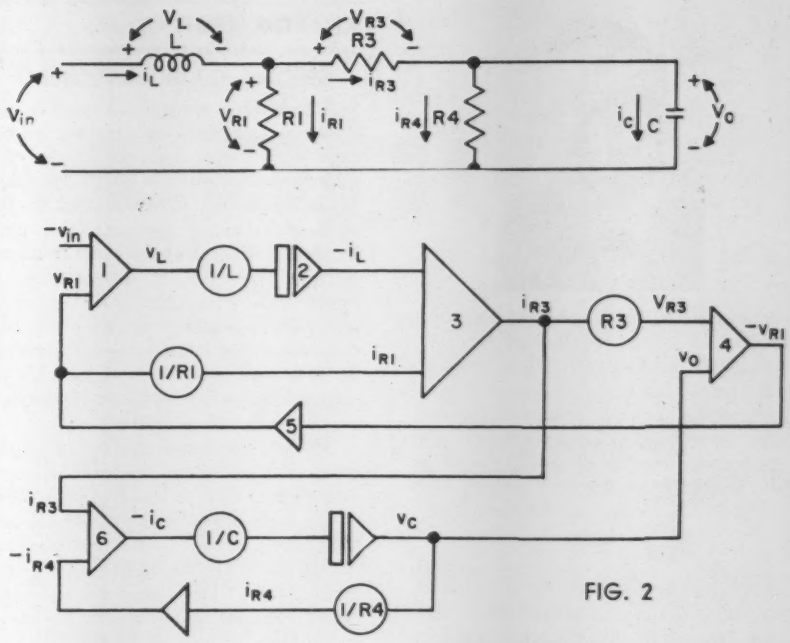


FIG. 2

tegrator 2). This is represented by the equation:

$$i_L = \int \frac{V_L\,dt}{L}$$

Since V_{R1} was assumed known, this can be multiplied by 1/R1, thus giving i_{R1}.

Now i_{R1} and i_L can be summed to yield i_{R3} (amplifier 3). This is represented by the equation:

$$-i_L + i_{R1} + i_{R3} = 0$$

This type of circuit tracing can be continued until the entire circuit has been completed and all the assumed voltages and currents have been generated, thus closing the system. The complete diagram for the circuit in Figure 1 is shown in Figure 2.

After the block diagram has been completed it can be checked out to some extent—first against the circuit diagram, then to see if the physical connections will function properly. To name a few of these checks, the block diagram should usually contain as many integrators as there are storage elements in the circuit. Also, if there are any algebraic loops, they should have a gain less than unity and should contain an odd number of amplifiers to assure negative feedback. Once these and other checks have been completed, the diagram is then scaled in the usual manner.

From the complete block diagram, the board for the computer can be wired. To check the wiring, a static test should be run. In this test, known voltages are placed on the integrators, and the effect of these voltages are measured and compared with calculated results. When agreement between the two sets of values is reached, the problem is ready for running. From this state on, the problem can be repeated and parameters varied by changing the potentiometer settings.

It has been pointed out that the analog method has the advantage of flexibility in adjusting the computer time with respect to problem time; this is nonexistent as such in the digital solution.

Another advantage of the analog computer is that it can be set up to ignore unwanted small fluctuations in the solution, whereas in the digital solutions all fluctuations—regardless of how small or unwanted—are followed by the numerical integrator.

The outstanding advantage of the digital method over the analog approach is that it is general and can handle a wide range of circuits. Circuits can be changed merely by furnishing different sets of data cards for each circuit to be analyzed. The analog method, on the other hand, is a one-shot method—that is, each circuit must be set up as a separate entity.

Also, the digital program is tested thoroughly in its formulation and all the "bugs" are taken out before performing actual analyses; hence, any erroneous results can be traced to unusual conditions rather than to the program itself. In comparison, in the analog solution the possibility of having the circuit wired incorrectly always exists and must be traced for each analysis, thus introducing another possible source of error.

Since both methods evaluate circuits consisting of linear and nonlinear circuit components, all devices such as transistors and diodes must be represented by means of equivalent circuits. The success of the analysis depends on the ability of these equivalent circuits to respond accurately in the same manner as the devices they represent. Also, one common cause of error can arise from the use of static characteristics in a second-order dynamic problem.

Simulation for Display System Design

Summary of the 13-page, 5-diagram report presented by W. E. Smith

During the improvement program for SAGE displays, it was desired to measure the changes in operator performance that resulted from changes in the display system design. To accomplish this end, a task was developed that stimulates* a semi-auto-

*!—Ed.

WELLINGTON E. SMITH received a BS and MS in Psychology from the University of Oregon. He worked for IBM as an instructor of computer programming before becoming associated with the Human Factors Department. He is presently manager of the Human Factors Department of IBM CCC, Kingston, New York.

matic tracking system. This task, Random Walk Monitoring, was presented to human operators and their performance on this monitoring task was measured. The efficiency with which they performed this task provided an index of "goodness" of design.

A 12-minute movie describing the development and possible uses of the Random Walk Monitoring technique was shown.

A queueing model of the monitoring system was developed which included relevant display and human parameters. This model was validated against the basic Random Walk results and spot-checked against several conditions of display design changes and operator instructions. The model was used to predict the effect of interactions of relevant variables and to determine parameters for further research. An important factor in the design was the method of utilization which operated a digital computer in a mode of continuous operator control. This method of program design provided for ease of programming for solution to a multivariant problem in a relatively short time.

* * *

Walter Brunner (EAI Computation Center, Princeton) gave the sixth talk at this meeting. However, as it was much the same as "An Iterative Procedure for Model Building and Boundary Problems," which he subsequently presented at the WJCC, and which was published in the Proceedings of that meeting, we will not repeat the coverage here.

SPECIAL GAIN AMPLIFIERS

A technique sometimes used to obtain a special gain or produce an exceptionally high gain is to insert a potentiometer in the feedback path of an amplifier. This results in the multiplication of the amplifier gain by the reciprocal of the potentiometer setting. However, it is not wise to apply this procedure blindly since with the computer as with all else you cannot get something for nothing. In this case, gain is bought with increased noise and poorer frequency response in the amplifier.

The effect of this system of amplification was tested on an Electronic Associates, Inc., 16-6H-6 amplifier using a Hewlett-Packard Model 200 CD oscillator and a Hewlett-Packard Model 152 Oscilloscope as the test instruments. The computer circuitry was as shown in Figure 3. The noise measurements were made with all the inputs to the test amplifier disconnected and the peak-to-peak noise measurements were plotted on a logarithmic scale as a function of frequency. The principal component of the noise was a 60-cycle oscillation which, as can be seen from Figure 4, increases quite rapidly as the gain of the amplifier is increased.

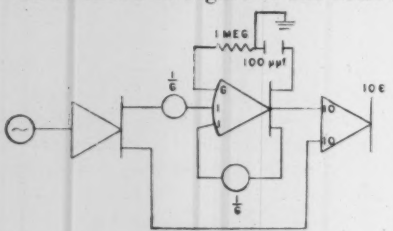


FIG. 3

The effects of increasing gain on frequency response were evaluated in terms of dynamic error. This quantity is defined as the difference between the input and output signals to the amplifier under test. The test data for a 35-volt peak-to-peak input signal are plotted against frequency on a logarithmic scale in Figure 5. The curves for constant amplifier gain show that the peak-to-peak amplitude of dynamic error is directly proportional to the frequency of oscillation. Thus

$$\epsilon = KVf$$

Where ϵ and V are in volts peak-to-peak, f is in cycles per second and K has the units of time. Table 1 gives the values of K for the gains tested. For values of gain greater than unity, the values of K are described by $\Delta K = 1.6\,\Delta G$, where G is the amplifier gain.

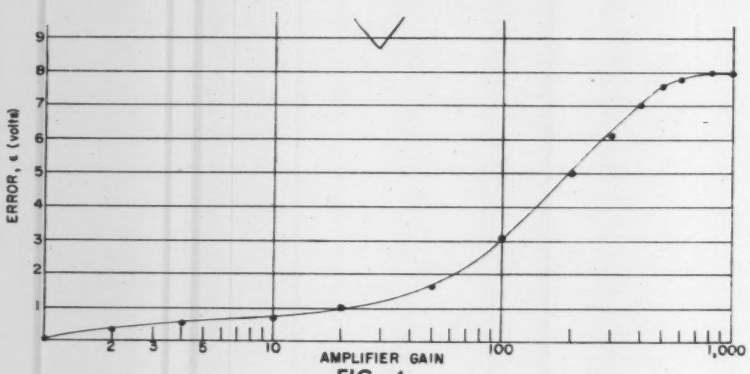


FIG. 4

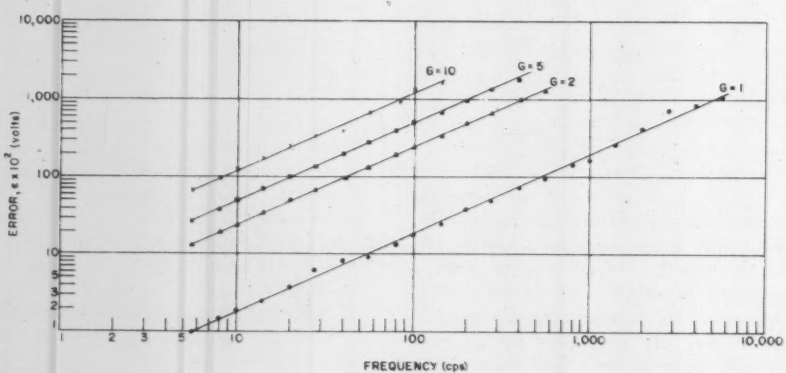
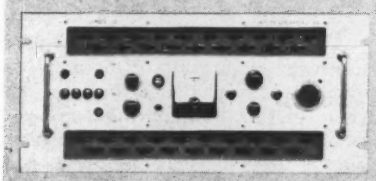


FIG. 5

THREE Analogical* IDEAS



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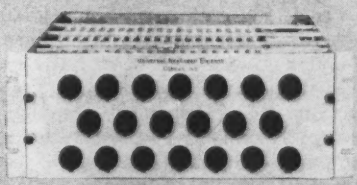

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Table 1—K versus G

G	K sec
1	1.6×10^{-5}
2	2.45×10^{-6}
5	7.1×10^{-5}
10	1.5×10^{-4}

Most computer specifications are written in terms of "static accuracy," usually on the order of 0.01%. It is interesting to look at the "dynamic accuracy" of the normal amplifier and the bandwidth of the special gain amplifier for various gains. In Table 2, the rows apply to the various gains and the columns denote maximum dynamic error, while the entries are the maximum frequencies which the amplifier will pass at the given gains within the allowable dynamic error range. The lack of an entry indicates that the noise level on the amplifier exceeds the maximum allowable dynamic error.

Table 2—Maximum Frequency Versus Gain

Maximum Dynamic Error / Gain	10%	1%	0.1%
1	1850	185	18.5
2	1400	140	
5	480	48	
10	220	22	

The results indicate that there is no easy way around the limitations of the computer. In the case of special gain amplifiers, one must consider both frequency response and noise requirements before introducing them into the simulation. Particular care must be used in simulating high-gain loops to prevent the special gain amplifier dynamics from dominating the combined dynamics of the loop.

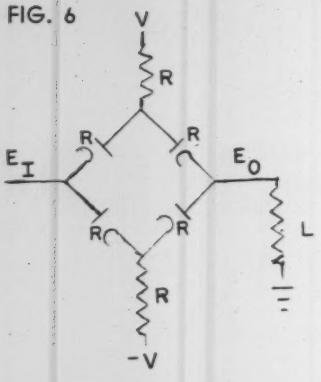
Hard Limiter

The shunt limiter which is in general use does not provide a sharp knee, and the slope in the limited region is not zero. The rounded knees are due principally to the fact that the resistance of a diode does not change instantly as the applied voltage passes through zero. The "softness" of the limit is due to the finite gain through the limiting circuit, which usually has a value on the order of one thousand. The net effect of these characteristics is to make the shunt limiter appear as an elastic stop in a simulation.

The simulation of an inelastic stop can be accomplished with a diode bridge circuit (Figure 6) which is used as a series limiter. This device has both sharp knees and a zero slope in the limited region of operation.

The following relationships can be derived from the nodal current equations.

FIG. 6



$$e_o = e_i \frac{1}{\left(1 + \frac{r}{R}\right)}; \quad |e_i| < V$$

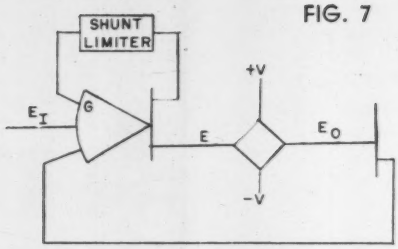
$$e_o = \frac{e_i}{|e_i|} V \frac{1}{1 + \frac{(r+R)}{L}}; \quad |e_i| > V$$

where R = 100 K, r = forward resistance of the diode, L = load resistance.

A complete analysis of this circuit appears on page 247 of *Analogue Computation*, Vol. 1 by Stanley Fifer, McGraw-Hill, 1961.

From the equations it is apparent that in the non-limited region of operation the bridge limiter gain is not unity and that the limit is not exactly

FIG. 7



the applied voltage V. It is possible to set up curves to determine correct values of V for a given value of limit voltage, but since the diodes tend to vary somewhat in their characteristics, it is much more practical to set them by experiment.

The non-unity gain can be compensated for by the circuit shown in Figure 7. The high gain amplifier produces an output voltage e which is sufficient to force the relation $e_o = -e_i$.

The purpose of the shunt limiter is to prevent saturation of the amplifier during the periods of limiting. The value of this limit may be any convenient voltage greater than V, usually ±100 volts. This circuit has been in use for the last year and has been found to be quite satisfactory for all applications requiring a hard limit.

SCI Activities

Jack Sherman, Chairman of the Board of SCI, has recently been appointed Associate Editor of IRETEC (Institute of Radio Engineers, Transactions on Electronic Computers), where he will give special attention to papers on analog and hybrid computers.

Jack believes—and your Ed and the rest of the Board agree—that in his new capacity he will be in an excellent position to complement the coverage of Simulation offered by this *Newsletter*.

The *Newsletter* will be kept informal and as timely as possible, and in the future will seldom if ever publish complete articles. Articles submitted for IRETEC, on the other hand, will be given a formal review by qualified referees.* This, plus the method of publication, means that as they cannot be as timely, the IRETEC articles must be of lasting interest.

Such articles are hereby solicited. They should be submitted complete, in triplicate, to: Jack Sherman, Simulation Councils Inc., Box 504, Sunnyvale, California.

*Kill the umpire!—Ed.

Programs Announced

Western Simulation Council

12 May 1961, Ambassador Hotel, Los Angeles, Calif.

A panel discussion on "What is the future of Analog Computation?," moderated by **George Bekey** (Space Technology Labs and UCLA, Los Angeles). Panel members: **W. Comley** (Douglas, El Segundo, Calif.); **H. Ehlers** (Autonetics, Downey, Calif.); **R. Horwitz** (General Dynamics/Astronautics, San Diego); **R. Howe** (University of Michigan and Applied Dynamics, Inc., Ann Arbor); **W. McLean** (North American Aviation, Los Angeles); **R. Tomovic** (Boris Kidric Institute for Nuclear Sciences, Belgrade, Jugoslavia, and UCLA).

Eastern Simulation Council

12 June 1961, University of Pennsylvania, Philadelphia.

"Special Techniques for the Solution of Partial Differential Equations."

Papers by **D. Greenwood,** "Review of Conventional Analog Tech-

niques"; **V. Paschkis,** "Two Concepts of the Direct Analog Computer: Simulator and Equation Solver"; **H. B. Keller,** "Review of Conventional Digital Techniques"; **H. Witsenhausen,** "Survey of Non-Standard Techniques for the Solution of Partial Differential Equations"; **G. Stubs,** "Serial Solution of Process Problems Using a Large-Capacity Memory"; **J. Nelson** and **S. Fried,** "Illustrative Examples Using a New Technique for the Solution of Complex Partial Differential Equations"; **Ben Clymer,** "Simulation of the Dynamics of Fluid Systems"; **E. Liban,** "Fourier Transform Method for Solving the Heat Equation"; **W. Brunner,** "Serial Solution Techniques as Applied to Fourier Heat Equation."

The papers will be followed by a panel discussion, with **Art Rubin** as chairman.

Reports Received, to be Published

From **P. J. Hermann,** complete papers and comments on the Midwestern Simulation Council meeting of 13 March at the University of Michigan, on "Analog Equipment—New Types and Future Needs."

Information (Without Theory)

So far all the contributions to "Analog Techniques" have been made by **Tom Anderson** of Lockheed. How come? Certainly some of the rest of you have trick ideas which others can use; send them in!

* * *

Are all of you aware of the coming

ТРЕТЬЯ МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ ПО ВОПРОСАМ АНАЛОГИЧНОГО ИСЧИСЛЕНИЯ

No? Well, it's the Third International Conference on Analog Computation, organized by the Association Internationale pour le Calcul Analogique and the Jugoslav Committee for ETAN*, which will open in Belgrade on 4 September and last until the 9th.

Surprisingly, (to your Ed, at least) the list of participants from the US looks like a roster of Simulation Council members:

Bekey, G. A. (STL, Los Angeles)
Diamantides, N. D. (Goodyear, Akron)
Karplus, W. J. (UCLA, Los Angeles)
Korn, G. A. (University of Arizona, Tucson)
DeLand, E. C. (Rand Corporation, Santa Monica)
Low, H. (STL, Los Angeles)
Neustadt, L. (STL, Los Angeles)
Palevsky, M. (Packard-Bell Computer, Los Angeles)
Rideout, V. C. (University of Wisconsin, Madison)
Sherman, J. E. (Lockheed, Sunnyvale, Calif.)
Tomovic, R. (Boris Kidric Institute of Nuclear Sciences, Belgrade)

*We don't know what these letters stand for. Can anyone help us out?—Ed.

Letters

The inspiration for the following two letters was a panel discussion which has not yet been reported in your *Newsletter*. We considered holding them until the discussion is written up, but decided that they are so timely—and complete in themselves—that they should be published as soon as possible.

Editor, S/C N/L:

After having attended the Western Simulation Council meeting on May 12, 1961, I am left with these impressions. Primarily, I think that except for the remarks of Prof. Tomovic, the meeting fell far short of my "great expectations." Too much attention was given to the problem of educating people on the advantages of analog computers. Whether or not the analog computer will remain with us is not entirely a question of educating industry and the scientific community. It is a question of whether the computer itself will be developed and improved in such a way so that it can solve the ever increasing complexity of problems that constantly arise. The analog computer of today is the same machine as that of ten years ago with few exceptions. No art can remain stagnant and survive.

For myself, I visualize the development of a new class of hybrid computers, neither analog nor digital per se, but a happy combination of both. The analog is desirable for its dynamic characteristics and the intimate relationship between the problem and the problem solver; whereas, the digital features will be called upon to carry out the exotic logic and absolute control for which it is best adapted.

At any rate, the "dialogue of the analog" in future years must necessarily involve a vocabulary many of whose terms are unknown to all of us today.

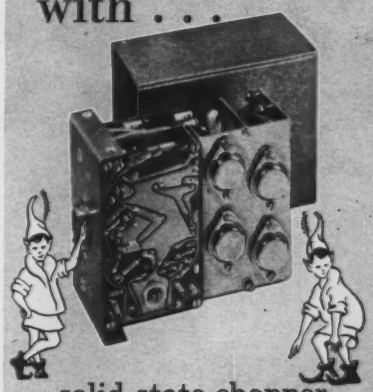
I am not willing to draw the curtain on analog computers until such time as it is apparent that no further development is forthcoming.

Thomas P. Fitzgibbon
Supervisor Analog Devices

Mass. Inst. of Tech.
Dept. of Aeronautics and Astronautics
Instrumentation Lab.,
Cambridge 39, Mass.

(Second letter by Bruno Ulrick of Hughes aircraft Co., will appear next month)

This is a transistorized operational amplifier with . . .



solid-state chopper and internal oscillator

BRIEF SPECIFICATIONS

GAIN: 10^7 at dc; unity crossover at 300 kc.

OUTPUT: ±50 V at 20 ma load; ±25 V at 100 ma load.

CAPACITIVE LOAD: Up to 0.1 μf.

INPUT CURRENT: 10^{-10} A.

INPUT IMPEDANCE: 1 Megohm.

TEMPERATURE RANGE: 0°C to +50°C.

DRIFT: 10 μV within 24 hours at constant ambient temperature; 50 μV from +15°C to +35°C.

CIRCUIT: All transistorized, including solid-state chopper and internal oscillator.

WEIGHT: 2 pounds.

POWER REQUIREMENTS (2.5k load): +60 V at 60 ma; −60 V at 40 ma. Power supply available from Boonshaft and Fuchs, Inc.

there's a lot of magic in B & F test equipment

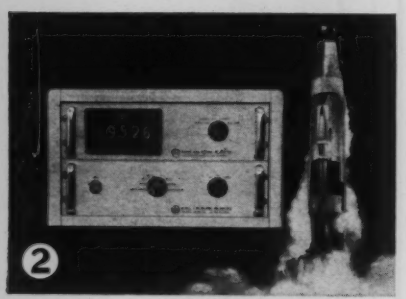
Boonshaft and Fuchs Inc.

HATBORO INDUSTRIAL PARK • HATBORO • PA.

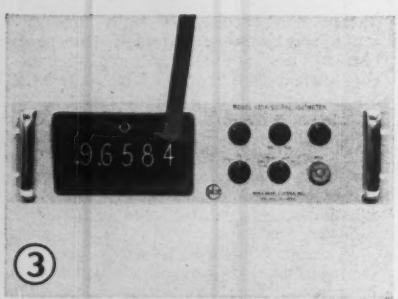
CIRCLE 160 ON READER-SERVICE CARD

When does it pay to pay more for a digital voltmeter?

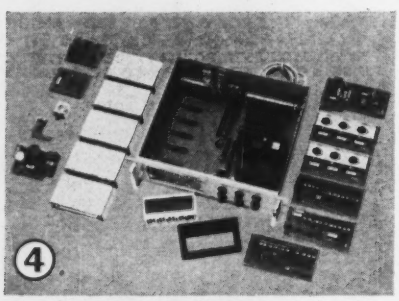
WHEN RELIABILITY is of uncompromising importance, consider NLS Series 20 instruments with advanced transistorized logic and mercury-wetted relays. The M24, above, which measures DC voltage, DC voltage ratio or resistance in ⅓ second, has been selected by major missile manufacturers after thousands of hours of competitive life testing.



WHEN SPEED, in the order of 200 measurements per second, is required, specify the NLS V44 All-Electronic DVM. Here is an instrument specifically designed to solve the special problems encountered in high-speed measuring and data logging.



WHEN ACCURACY—full five-digit accuracy—is demanded by your application, use the NLS V35A. This instrument features resolution of 0.001% over the entire range, a result of mathematically perfect "No-Needless-Nines" logic.



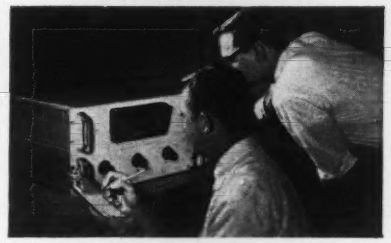
WHEN EASE OF SERVICING is of vital concern, you will find it in any NLS premium instrument. The higher-priced V44, M24, V24, R24 or the medium-priced V35A and V34A (shown above)—all feature 99% plug-in modular construction for spotting and correcting malfunctions in minutes instead of hours or days.

Originator of the Digital Voltmeter

non-linear systems inc.

DEL MAR, CALIFORNIA

CIRCLE 94 ON READER-SERVICE CARD



You can buy an NLS Digital Voltmeter for as little as $1,125 . . .

. . . but there are many times when it pays to pay much more! When accuracy, reliability, speed, servicing ease or versatility cannot be compromised, you'll gain far greater long-term economy by specifying one of these *premium* NLS instruments:

❶ M24 Multi-Purpose Instrument—Measures DC voltage from ±.0001 to ±999.9 and DC voltage ratio to ±.9999 (±0.01% accuracy), resistance from 0.1 ohm to 1 megohm . . . ⅓ second balancing time . . . with accessories, measures AC voltage or AC ratio, low-level DC . . . completely automatic . . . output for data logging. $5,650

V24 Voltmeter-Ratiometer—Similar to M24 except it does not measure resistance. $4,950

R24 Ratiometer—Measures DC ratio with ranges of ±.9999/9.999. $4,650

❷ V44 All-Electronic Voltmeter—200 readings per second . . . measures DC voltages from ±0.001 to ±999.9 . . . output for data logging . . . input impedance 10 megohms on all ranges without internal or external preamplifiers . . . recommended for high-speed applications requiring maximum reliability and dependable ±0.01% accuracy . . . there are no decade or amplifier potentiometers to trim; the V44's "NO POTS AT ALL" stability is designed in, not trimmed in. $6,150

❸ V35A Transistorized Voltmeter-Ratiometer—This all-transistorized instrument is the fastest, most versatile, true 5-digit voltmeter with the Factual Fifth Figure, full 5-digit resolution of 0.001% . . . measures DC voltage from ±0.0001 to ±999.99, DC voltage ratio from ±00.001% to ±99.999% . . . with accessories, measures AC voltage, low-level DC . . . features No-Needless-Nines logic, plug-in oil bath stepping switches . . . output for data logging. $3,750

❹ V34A Transistorized Voltmeter Ratiometer—4-digit quality and performance companion to V35A. $3,150

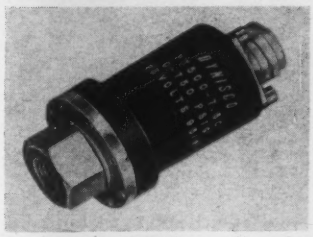
NLS offers a complete line of digital voltmeters . . . both by purpose and by price. In addition to these premium instruments, six low-cost models in the Industrial Series are offered by NLS, pioneer of low-cost DVMs. To see any NLS instrument in action or receive more information, write NLS or contact any NLS office or representative.

non-linear systems, inc.
DEL MAR, CALIFORNIA

CIRCLE 94 ON READER-SERVICE CARD

IGS NEW INSTRUMENTS

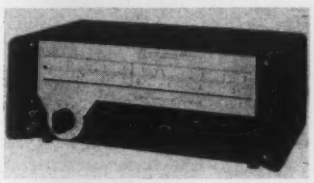
STRAIN GAGE TRANSDUCER



New Dynisco PT500 semi-conductor line of Pressure Transducers utilizes a novel and effective temperature and linearity compensation technique. Accuracy is comparable with that of the best metal-wire-type strain gage instruments. High output level (5 v at 1000 ohms) can save at least one stage of amplification. Repeatability: 0.1% FS; non-linearity: max 0.5% FS, Hysteresis: max 0.25% FS.—*Dynisco, Div. of Amer. Brake Shoe Co.*, 42 *Carleton St., Cambridge* 42, *Mass.*

CIRCLE 231 ON READER-SERVICE CARD

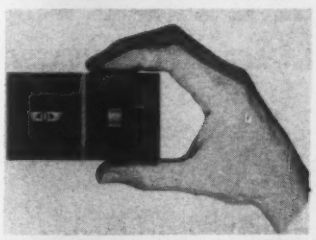
DC VOLTMETER



New Model HV-160 d-c Servo Voltmeter has potentiometric input (over 100 Mohms) on ranges from 3 mv to 1 v, and 10 Mohms on ranges from 3 to 300 v. Accuracy is 0.15% on 11 scales.—*Houston Instrument Corp., Box* 22234, *Houston* 27, *Tex.*

CIRCLE 232 ON READER-SERVICE CARD

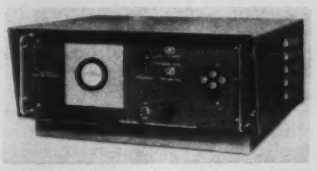
CALIBRATION TESTER



New Calibration Tester BH153 is a direct-reading adjustable voltage source, simulating the d-c output of transducers with a setting accuracy of 0.5%. Used for field or laboratory testing of recording or indicating instruments in the mv or μv range. Consists of a potentiometer of infinite resolution, with a Zener-referenced bridge network.—*Howell Instruments, Inc.*, 3479 *West Vickery Blvd., Fort Worth* 7, *Tex.*

CIRCLE 233 ON READER-SERVICE CARD

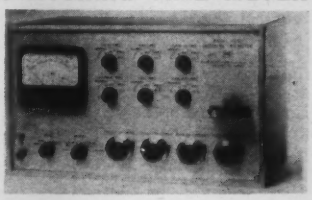
AC VOLTAGE CALIBRATOR



New Precision Voltage Calibrator, Model VC-555A, offers three output voltages of 5, 50, and 500 vrms at two switch-selected frequencies of 400 cps and 10 kc. Features include output voltage and frequency stability to 0.05% (short term) low total harmonic distortion of 0.1% max.—*Elin Div. International Electronic Research Corp.*, 135 *West Magnolia Blvd., Burbank, Calif.*

CIRCLE 234 ON READER-SERVICE CARD

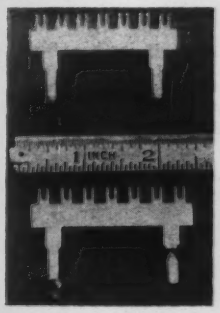
SWITCHING TIME METER



New Switching Time Meter, Model 140A, measures switching characteristics and diode recovery time. Provides six channels of time difference information to very high accuracies. Transistorized with printed circuit construction.—*E-H Research Labs.*, 163 *Adeline St., Oakland* 20, *Calif.*

CIRCLE 235 ON READER-SERVICE CARD

TERMINAL STRIPS



New plastic Mounting Strips are made of polyethylene and polypropylene plastic. Volume resistivity is a million times better than phenolic, 10,000 times better than ceramic; dielectric constants are 400% better than phenolic, 300% better than ceramic; loss factors are 200 times better than phenolic, 30 times better than ceramic strips. Bulletin MS161.—*Electro-Glass Lab.*, 4000 *S. W.* 114*th St., Beaverton, Ore.*

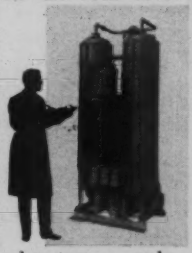
CIRCLE 236 ON READER-SERVICE CARD

JOHN E. POLIS
Senior Design Application Engineer of our Molecu-Dryer Division, reports on

LOW COST INSTRUMENT AIR DRYING

DELIVERY OF CLEAN, DRY AIR AT LOW COST for a "dry box" installation at one of our customer's plants . . . is now being accomplished with a Hayes MS Series Recirculating Molecu-Dryer. The same can be done for your instrument air system . . . where moisture causes rust, clogs up instrument ports, and creates freeze-ups in the air lines.

A NEW HAYES TYPE MSX MOLECU-DRYER has been developed to supply pure, dry air at −100°F and solve instrument air problems. An externally heated dryer, the MSX is a complete, compact, high-capacity unit featuring a simplified control system . . . makes drying and reactivating operations easy, automatic—at lowest cost ever.



SHELL AND TUBE DESIGN has been designed for safe, high pressure working ranges to 500 psig. Many other design innovations for which patents have been granted have also been applied to this and other Hayes Molecu-Dryer units. The unique feature of the new MSX, however, is the downflow stream which eliminates fluidizing of the desiccant bed, especially with high velocity flows.

SHORT CYCLES — CONTINUOUS FLOW. Dry and purge circuits of the MSX are independent and completely automatic . . . operate in alternating 4-hour cycles. Larger size Linde® Molecular Sieves are used, together with down-flow adsorption, to increase flow rates as much as 3 to 4 times that of comparable dryers with upflow stream.

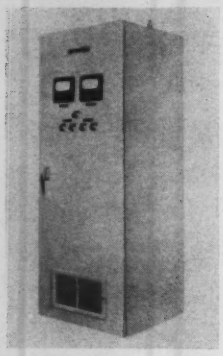
A WIDE SELECTION OF FLOW CAPACITIES and pressure ranges are available to meet your particular instrument air drying needs. Bulletin 1060C gives full details on the new Hayes Type MSX Molecu-Dryer. For your copy, write C. I. Hayes, Inc., 944 Wellington Ave., Cranston 10, Rhode Island.

C. I. HAYES, INC.
Established 1905

It pays to see Hayes for metallurgical guidance, lab. facilities, furnaces, atmosphere generators, gas and liquid dryers, pHayes-Master (TM) control units.

CIRCLE 95 ON READER-SERVICE CARD

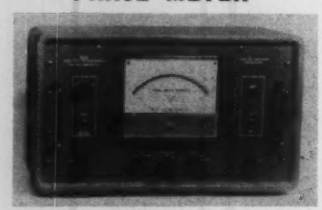
LIQUID RHEOSTAT



New Model HDR-1 (5) Liquid Rheostat supplies automatic operations from 5-100 kw, is continuously adjustable resistance for high power, high current application with dc or ac. Consists of fixed electrode and motor-driven electrode operating in electrolyte bath. Resistance range governed by concentration of solution and temp. Tap connections for single or three-phase.—*U.S. Controls, Inc.*, 410 *Fourth Ave., Brooklyn* 15, *N. Y.*

CIRCLE 237 ON READER-SERVICE CARD

PHASE METER



New Type 405 Series Meter measures phase angle between two alternating voltages, without either amplitude or frequency adjustment. Indicates, or plots phase-frequency curves on recorder or oscilloscope. Features include: Independence of meter reading of ratio of input signal amplitudes from 1 to 700, equal accuracy for symmetrical waveforms of any shape, etc.—*Ad-Yu Electronics Lab., Inc.*, 249-259 *Terhune Ave., Passaic, N. J.*

CIRCLE 238 ON READER-SERVICE CARD

ELAPSED TIME INDICATOR

New Model 5700 Elapsed Time Indicator operates only when electrical equipment is energized. Dial range is 99,999.9 hrs, or 99,999,9 min with 1/10 hr or 1/10 min minimum time indication, respectively.—*Automatic Timing & Controls, Inc., King of Prussia, Pa.*

CIRCLE 239 ON READER-SERVICE CARD

SERVO INDICATOR

New Precise Servo Indicator indicates remote shaft positions of 400-cps synchros, resolves, or potentiometers with guaranteed repeatability of 30 sec, accuracy of ±6 min. slew speed 9 deg per sec. Has numerical readout.—*Astrodyne Inc.*, 121 *Clinton Rd., Caldwell, N. J.*

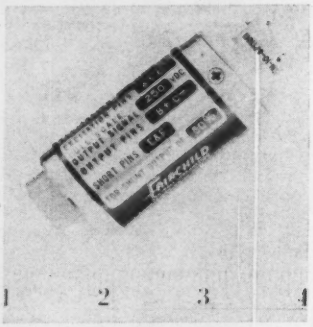
CIRCLE 240 ON READER-SERVICE CARD

ELECTRICAL THERMOMETER

New portable Model T-1 Electrical Thermometer determines temperature of surfaces, liquids, or gases by application of a thermistor sensing-probe to the surface of substance to be tested. Accurate to ½ to ¾% of the total instrument range.—*Ameresco, nc., 7 Center Ave., Little Falls, N.J.*

CIRCLE 241 ON READER-SERVICE CARD

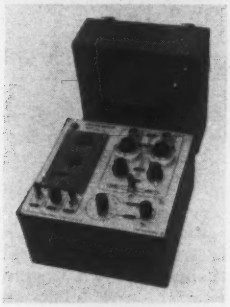
STRAIN GAGE TRANSDUCER



New silicon semiconductor Strain Gage Pressure Transducer, in ¼-lb airborne and 1-lb ruggedized models, gives 250-mv output without amplifier with 10 to 30-vdc excitation. Pressure range 0-100 through 0-10,000 psi gage or absolute, zero shift of less than ±0.25%; standard linearity 0.25% maximum through zero and 100% pressure points (special units available with 0.1% max); standard hysteresis 0.3% maximum (0.15% max, special).—*Fairchild Controls Corp.*, 219 *Park Ave., Hicksville, L. I., N. Y.*

CIRCLE 242 ON READER-SERVICE CARD

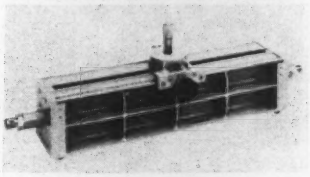
TRANSDUCER INDICATOR



New self-contained Transducer Indicator Model TI-2, measures output from bonded strain-gage-type load cells, employing d-c excitation, affording complete interchangeability of load cells and readout equipment.—*Allegany Instrument Co., Div. of Textron Electronics, Inc.,* 1091 *Wills Mountain, Cumberland, Md.*

CIRCLE 243 ON READER-SERVICE CARD

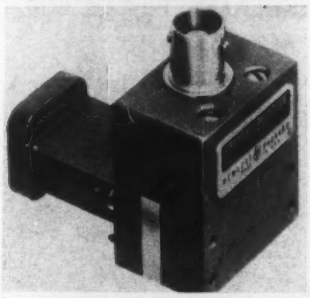
SLIDE-SCREW TUNER



New Model 872A Coaxial Slide Screw Tuner features independent phase and magnitude adjustments, precision, easy probe insertion control, and direct position readings for correcting discontinuities and for flattening waveguide and coaxial systems. Operates in 500-4000-mc frequency range; probe travel is at least one-half wavelength at 500 mc so that any phase of reflection may be compensated.—*Hewlett-Packard Co.,* 1501 *Page Mill Rd., Palo Alto, Calif.*

CIRCLE 244 ON READER-SERVICE CARD

CRYSTAL DETECTORS



New Crystal Detectors (Model K422A for K band, 18-26.5 GC, and Model R422A for R band, 26.5-40 GC) provide high sensitivity of 0.05 v/mw and flat response (within ±2 db) by mounting special silicon diode within waveguide. Crystal is mounted at end of tapered section of waveguide which matches crystal to waveguide inpedance, keeping SWR low over entire waveguide band (maximum SWR, 2.5).—*Hewlett-Packard Co.,* 1501 *Page Mill Rd., Palo Alto, Calif.*

CIRCLE 245 ON READER-SERVICE CARD

MODEL 205 PRECISION MILLIVOLT SOURCE

An accurate, compact self contained rugged battery operated source of D. C. Millivoltages suitable for general calibration and testing.

Condensed Specifications

- **Full Scale Output** . . . 0 to 10, 100 and 1000 Millivolts full Scale.
- **Open Circuit Linearity** . . . 0.1%
- **Stability** . . . 0.1%/8 hours after Stabilization
- **Source Resistance** . . . 0 to 100 ohms maximum (derived from drop across 100 ohm ten turn potentiometer)

Priced at $99.50 F.O.B. Middleport, N. Y.

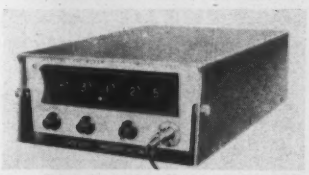
Write for complete Specifications

Monroe ELECTRONIC LABORATORIES, INC.

Middleport, New York

CIRCLE 97 ON READER-SERVICE CARD

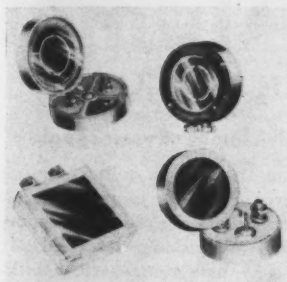
DIGITAL VOLTMETER



New Series 4000 Digital Voltmeter features ±1 digit accuracy, transistorized circuitry, full-four-digit measurement displayed on a unique 3-position tilting readout, and automatic ranging and polarity. Input impedance is 1000 Mohms at balance to ±9.999 v; 11 Mohms to ±999.9 v. Sensitivity is 0.1 mv. Model 4000 is for rack mounting, Model 4010 is for bench use.—*Electro Instruments, Inc.,* 8611 *Balboa Ave., San Diego* 11, *Calif.*

CIRCLE 445 ON READER-SERVICE CARD

PHOTOVOLTAIC CELLS



New encased or encapsulated selenium Photovoltaic Cells feature linear output, high sensitivity, long-term stability, resistance to shock and vibration, etc. Model 857 is of tinned silver construction in 1¼" dia with glass front, and hermetically or non-hermetically sealed. Model 859 is housed in a 2" electro-tinned brass case, filled with helium, and hermetically sealed. Plastic encased cells, Model 9971, are available in rectangular shapes. A 2⅝" Bakelite unit, Model 596, is available for use where atmospheric conditions are favorable.—*Daystrom, Inc., Weston Instruments Div.,* 614 *Frelinghuysen Ave., Newark* 12, *N. J.*

CIRCLE 446 ON READER-SERVICE CARD

DEGAUSSER

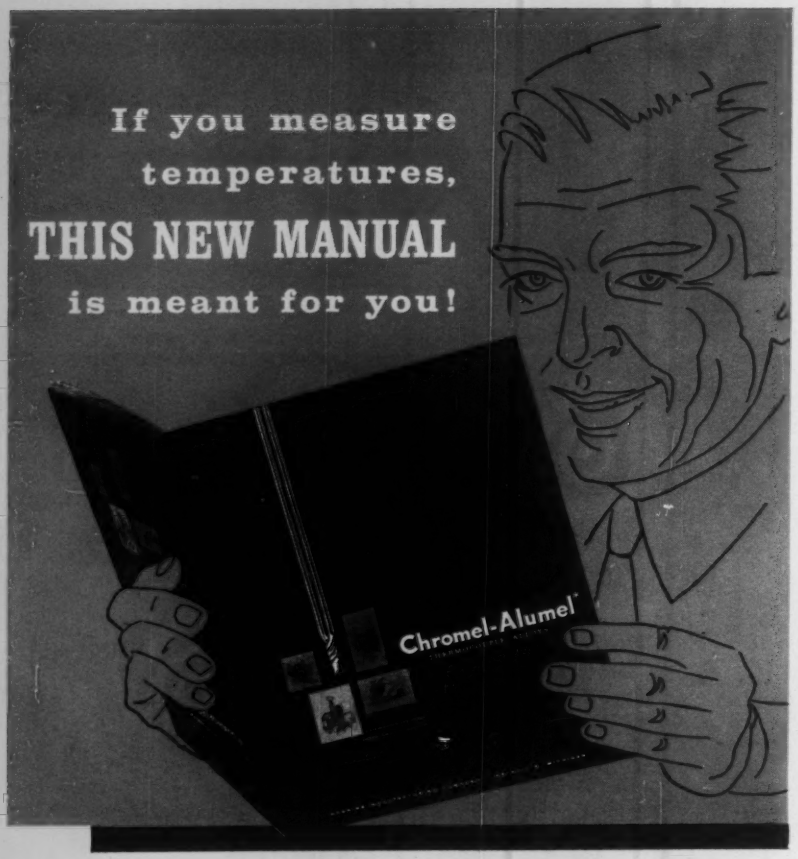
New Magneraser Demagnetizer produces complete erasure of recorded signal on all brands of tape and ¼", ½", or 16- and 35-mm magnetic sound film, on plastic or metal reels of any size from 5" to 15". Background noise level is lowered 3 to 6 db below that of virgin, unused tape. Includes a momentary push-button control safety on-off switch. Model 200C is for 100-130 v; Model 220C for 200-260 v.—*Amplifier Corp. of Amer.,* 398 *Broadway, New York* 13, *N. Y.*

CIRCLE 447 ON READER-SERVICE CARD

LEAK DETECTOR

New Type 24-510 Radiflo Leak Detector tests hermetically sealed components for leaks in the 10^{-11} atm cc/sec range. Testing is by activation with a radioactive tracer gas, Krypton 85, under pressures up to 200 psig, and inspected with a scintillation counter.—*Consolidated Electrodynamics Corp., Subs. of Bell & Howell,* 360 *Sierra Madre Villa, Pasadena, Calif.*

CIRCLE 448 ON READER-SERVICE CARD



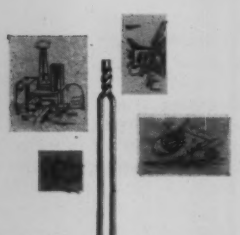
Contains detailed technical data on the entire family of

Chromel-Alumel*

THERMOCOUPLE ALLOYS

"How to make better use of Chromel-Alumel thermocouples"

That's the subject covered in detail by this new basic guide to more accurate temperature measurement. It gives complete information on the entire family of Chromel-Alumel thermocouple alloys—special purpose grades as well as Standard Guaranteed Millivoltage materials. It clearly states Hoskins Accuracy Guarantees—lists temperature-millivolt equivalents for Chromel vs Alumel—explains inspection and calibration procedures. What's more, it also contains much useful technical data on testing, fabricating and protecting thermocouples—covers special applications involving reducing and corrosive environments, high temperature oxidizing atmospheres, precision laboratory work, jet engines, nuclear reactors and cryogenic temperatures. So if you're concerned with accuracy, reliability, economy in measuring temperatures ranging from −300° to +2300°F., this manual is a *must* for you! Write for your free copy today.



**The names "Chromel" and "Alumel" are registered trademarks of*

HOSKINS MANUFACTURING CO.

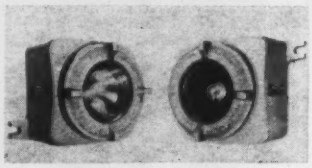
4445 Lawton Avenue • Detroit 8, Michigan

In Canada: Hoskins Alloys of Canada, Ltd., Toronto, Ontario

Producers of Custom-Quality Resistance, Resistor and Thermo-electric Alloys Since 1908

CIRCLE 98 ON READER-SERVICE CARD

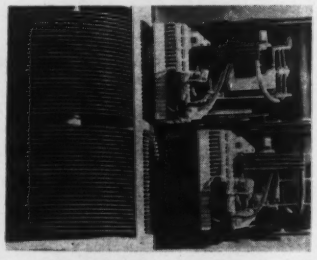
INFRARED DETECTION SYSTEM



New Tattleguard, an infrared illegal-entry Detection System, consists of two basic units, a transmitter and a receiver, between which an infrared beam is passed. Operates on 12 vdc and is completely transistorized. Bulletin 1030.—*Almor Instrument Co., 420 N. LaSalle St., Chicago 10, Ill.*

CIRCLE 246 ON READER-SERVICE CARD

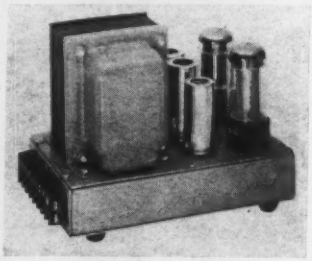
DISC STORAGE UNIT



New IBM 1301 Disc Storage Unit increases efficiency of IBM computers. Comb-like access arms have vertically-aligned read/write heads, one to a disc surface, to provide reading and writing of related information in corresponding disc tracks, eliminating need for vertical access motion. Unit enables new high-volume processing applications not previously feasible.—*International Business Machines Corp., Data Processing Div., 112 East Post Rd., White Plains, N. Y.*

CIRCLE 247 ON READER-SERVICE CARD

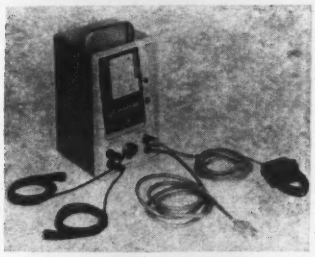
REGULATED POWER SUPPLY



New Regulated Power Supply, Model RS205A, operates over a current range of 0 to 50 mamp, continuous duty. Filament output is 6.3 v CT a-c- @ 3 amp. Three versions of the Model RS205A offer, respectively, modular construction, rack mounting, and rack mounting with 3½" meters. Voltage regulation is 0.05% load, line; ripple and noise. 5 mv maximum peak to peak; recovery time is less than 25 μsec.—*Trans Electronics, Inc., 7349 Canoga Park, Calif.*

CIRCLE 248 ON READER-SERVICE CARD

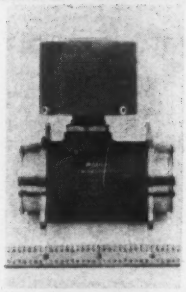
POWER TESTER-RECORDER



New Model 113 Recorder-Tester tests a-c voltage and current. Switch selects three voltage ranges (0-150, 0-300, 0-600 v), four current ranges (0-15, 0-30, 0-60, 0-150 amps); "read and write" feature permits direct reading or recording at twist of knob; accuracy, 3%.—*Rustrak Instrument Co.*, 130 *Silver St., Manchester, N. H.*

CIRCLE 249 ON READER-SERVICE CARD

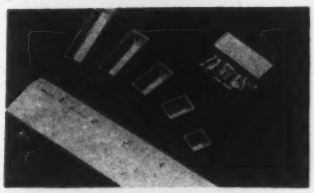
TURBINE FLOWMETER



New Turbine Flow Sensor with d-c output has miniature frequency-to-d-c converter that attaches directly to the sensor. Features are: Output of −24 to +24 mv dc, biased around 6vdc (0-5 vdc is available); output impedance of 350 ohms; rolloff circuit to provide inverse gain to frequency characteristics for noise rejection; wide temperature range through the use of silicon transistors; low power requirement of 25 ma max; 12 g rms vibration; 100 g shock; accuracy of ±¼%.—*Waugh Engineering Co.*, 7842 *Burnet Ave., Van Nuys, Calif.*

CIRCLE 250 ON READER-SERVICE CARD

MOLDED PLASTIC SHELLS



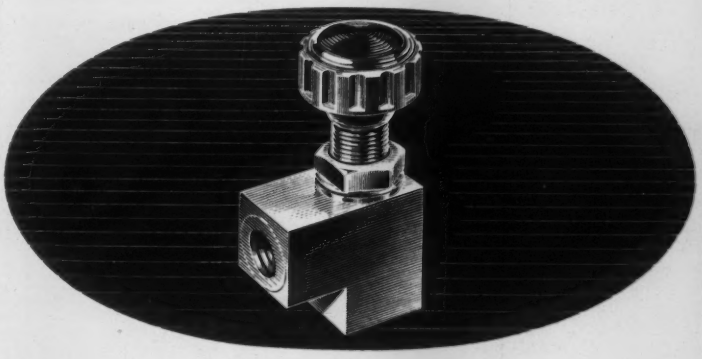
New line of high-temperature Plastic Shells for encapsulating miniature electrical assemblies, computer modules, etc. is molded from orlon-filled diallyl phthalate and measures approximately ½" x ½", up to ½" by 2" in any height from 0.2" to 0.6". Wall thickness is 0.030". Withstand up to 250°F, flame resistant. Expansion 55 ppm/°C. Approved under MIL-M-18794, SDI-5.—*Wells Electronics*, 1701 *S. Main St., South Bend, Ind.*

CIRCLE 251 ON READER-SERVICE CARD

PRECISION MADE FOR PERFORMANCE!

ROBBINS VALVES DESIGNED TO SAVE YOU MONEY!

Why let replacement costs and downtime caused by inferior valves ruin your scheduling and waste your money?
ROBBINS VALVES are specifically designed to prevent and eliminate such waste. Design capabilities, test programs, manufacturing procedures, quality control (and even packaging) at Robbins are all directed toward one objective... to produce and offer valves of highest quality that will give you the greatest possible economy and reliability over many years of service.



A FEW OF THE FEATURES OF THAT WILL PROTECT YOUR BUDGET ROBBINS VALVES

* Over 4 to 1 burst factor
* Quality valves that can be completely serviced in less than 1 minute from the front of the mounting panel without removal from the line
* As many as 5000 cycles at full pressure rating before requiring service
* Barrel, spindle, spindle seals, barrel seals and seat in one complete barrel assembly, one unit
* Approved military specification quality control... for both military and civilian valves... meeting or exceeding MIL-Q-5923 and MIL-Q-9858
* All valves LOX cleaned... assembled and packaged to standards recommended by Aero Space Industries Ass'n.
* Shut-off's as low as 1 in-lb. at 1000 PSI... bubble tight
* Minute metering characteristics
* Replaceable soft seat
* Backed by warranty

*Write TODAY for 16-page fully illustrated brochure in color containing complete technical information!

HI-VACUUM TO 12,000 PSI! • OXYGEN HYDRAULIC PNEUMATIC • ANGLE GLOBE THREE-PORT MANIFOLD

ROBBINS Aviation Inc.

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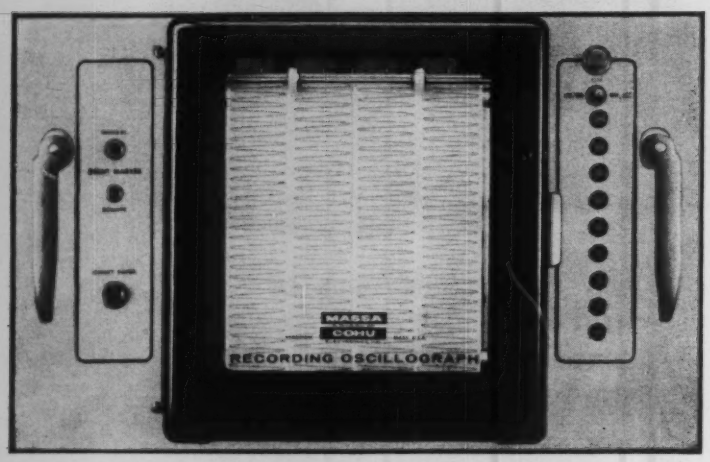
CIRCLE 99 ON READER-SERVICE CARD

ONLY MASSA RECORDERS COMBINE ALL 4

- HIGH-SPEED
- RECTILINEAR
- INK WRITING
- PLUG-IN PREAMPLIFIERS



MODEL
BSA-450
4 CHANNEL
40 MM

All of the exclusive features incorporated in previous Massa Recorders, including the *New Controlled Linearity Oscillographs*, are incorporated in the NEW 4 CHANNEL RECORDING SYSTEM. The all new front design greatly simplifies chart paper loading and permits full instant view of pen action and recorded signals on 7 x 10 writing table. Improved tracking, instant loading, accurate performance, are some of the novel features included in the new design.
Other features: 40 mm (full scale) Oscillographs, DC to 120 cps • Ink or electric rectilinear writing • 18 chart speeds, from 0.5 cm/hr to 200mm/sec • Event Marker • Automatic warning light for low chart indicator.

The new 4 channel recorder is now available in complete recording systems including individual transistorized driver amplifiers and power supplies for each channel, and a choice of interchangeable plug-in preamplifiers including DC, AC, Carrier and Chopper.

MASSA
A DIVISION OF
COHU
ELECTRONICS, INC.
276 LINCOLN STREET
HINGHAM, MASSACHUSETTS

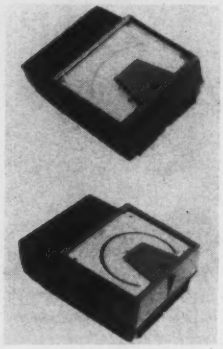
OTHER MASSA PRODUCTS

COMPLETE LINE OF
MULTICHANNEL AND PORTABLE RECORDING SYSTEMS

ACCELEROMETERS
HYDROPHONES
MICROPHONES
AMPLIFIERS
SONAR TRANSDUCERS

CIRCLE 100 ON READER-SERVICE CARD

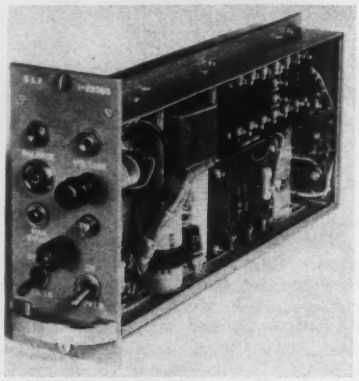
PORTABLE AMMETERS



New portable a-c and d-c Ammeters and Voltmeters feature taut-band suspension frictionless mechanisms, scale lengths of 6" and 10½", respectively, accuracy rating of ½%.—*Westinghouse Electric Corp., Box* 2099, *Pittsburgh* 30, *Pa.*

CIRCLE 252 ON READER-SERVICE CARD

STRAIN GAGE CONDITIONER



New universal input Conditioning Unit for data acquisition systems is a single-channel module with an integral floating power supply used with 1, 2, or 4-arm bridges. 6 modules are packaged in 8¾" panel, suitable for standard 19" relay rack mounting.—*B & F Instruments, Inc.*, 3644 *North Lawrence St., Phila.* 40, *Pa.*

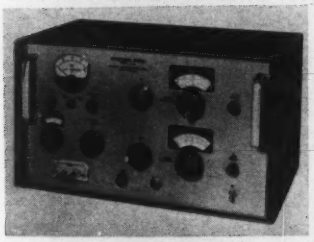
CIRCLE 253 ON READER-SERVICE CARD

CURVE FOLLOWER

New Data-Trak Function Generator has stylus which follows pencil-drawn program curve and turns a control potentiometer. Four 3-gang potentiometers can be driven by the same follower mechanism to provide up to 12 separate synchronized control signals. Uses standard strip-chart recorder paper.—*Research, Inc., Box* 6164, *Minneapolis* 24, *Minn.*

CIRCLE 254 ON READER-SERVICE CARD

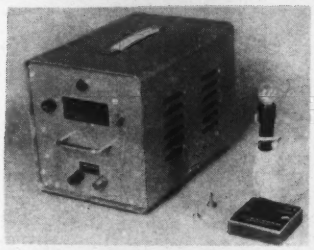
INDUCTANCE BRIDGE



New Model 63B Inductance Bridge for measurements in audio frequency ranges between 0.4 and 20 kc is basically calibrated variable frequency oscillator coupled to modified Maxwell bridge, includes self-contained tunable null detector. Features: direct reading calibration of inductance and resistance dials; resolution to 0.01%; inductance range, 0.02 microhenries to 11 henries; resistance range, 0.002 ohms to 110 Kohms; accuracy in order of 0.25%.—*Boonton Electronics Corp., Morris Plains, N. J.*

CIRCLE 255 ON READER-SERVICE CARD

CALIBRATED LIGHT SOURCE



New Quantalumen Model 141, consisting of a solid-state power supply which maintains a selected filament lamp at a constant intensity, is calibrated for candle power and color temperature and can be used with any 60 cps/100-135-v source without meters, supplementary power supplies, or other auxiliary equipment. Candle power ripple is estimated to be less than 0.0001%. Emits characteristics tungsten radiation.—*Quantametric Devices, Inc., Box* 1107, *Binghamton, N. Y.*

CIRCLE 256 ON READER-SERVICE CARD

PROTECTING GLOVES

New Polyethylene Gloves are made of 1-mil thick Visqueen film and are available in two sizes. Style WA is for glove sizes from 6 to 8 and style WB for sizes 8½ to 10½. Moisture-proof, odorless and unaffected by most acids or alkalis.—*Research Associates, Inc.,* 1618 *East Elizabeth Ave., Linden, N. J.*

CIRCLE 257 ON READER-SERVICE CARD

New Dykor®
Bi-Directional, High Speed

PERFORATED TAPE READERS and HANDLERS

PERFORATED TAPE READER... All solid-state photo-electric readers that give you *Performance*... stops before the next character at 1,000 characters per second; *Versatility*... handles 5 to 8-level tape, interchangeably; *Speed*... single or dual, up to 2,000 characters per second with complete dependability.

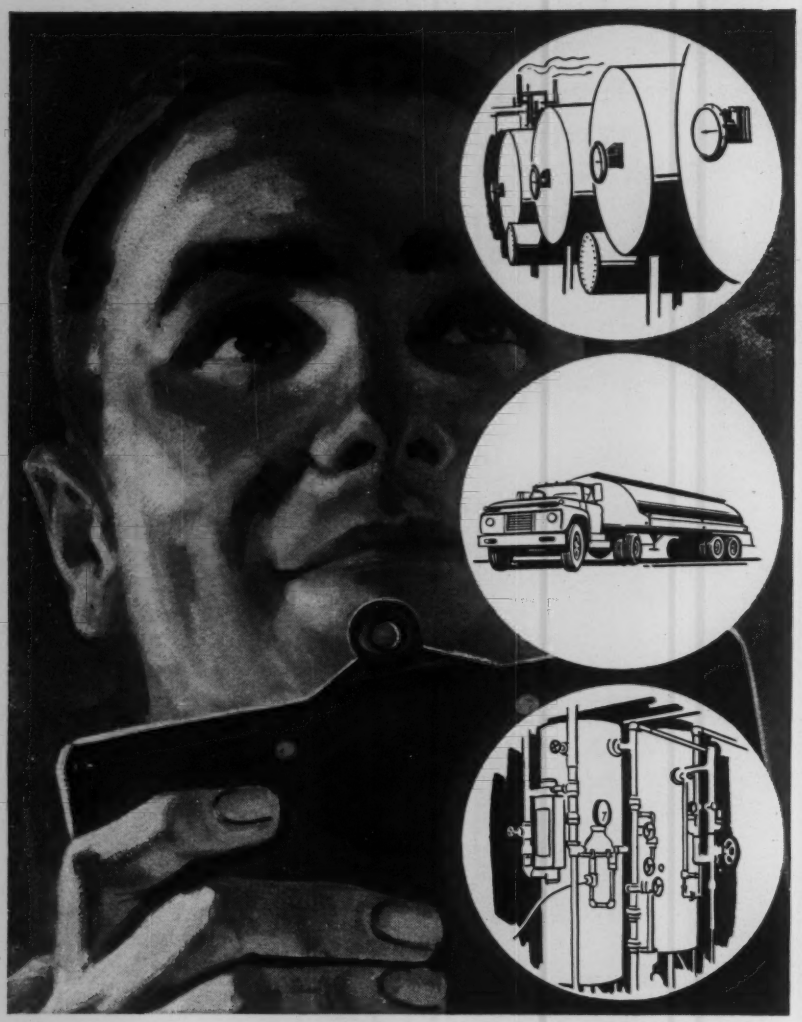
PERFORATED TAPE HANDLER... High speed... handles up to 500 feet of standard 5 to 8-level tape, in either direction, at speeds to 400 characters per second... rewinds at 150 inches per second... captive knob expansion hubs for ease of loading. Designed for use with uni-directional Model 3500 or bi-directional B3500 tape readers. For full technical information on these and other models, please write

DIGITRONICS

ALBERTSON, NEW YORK. PHONE HT 4-1000

WRITE FOR INFORMATION ABOUT DIAL-O-VERTER
HIGH SPEED DATA TRANSMISSION AND CONVERSION EQUIPMENT

CIRCLE 101 ON READER-SERVICE CARD



TANK CONTENTS AT-A-GLANCE with Dial-Type Liquidometer Gauges

For added assurance of accurate liquid quantity record keeping, specify easy-to-read Liquidometer gauges. Positive dial-and-pointer type indicators help to prevent erroneous readings . . . speed record keeping by showing tank contents at-a-glance.

Liquidometer gauges are available to measure and indicate virtually any liquid – at the tank site or remotely. Also available: integral or separate liquid level switches for automatic level warning or control. Float, hydrostatic, electric, or electronic operation can be supplied to meet your specific needs.

Let Liquidometer's forty years of experience in liquid level gauging and control work for you. Write for latest literature.

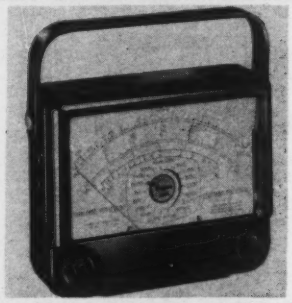
LIQUIDOMETER INSTRUMENTS

THE LIQUIDOMETER CORP.

Dept. E, LONG ISLAND CITY 1, NEW YORK

CIRCLE 102 ON READER-SERVICE CARD

VOLT-OHM-MILLIAMMETERS



New Models 267 and 268 Volt-Ohm-Milliammeters feature low microamp ranges (0-50 Model 267, 0-60 Model 268) and less circuit loading with sensitivity of a-c voltage ranges to 5000 ohms/volt. Details in bulletin.—*Simpson Electric Co., 5200 West Kinzie St., Chicago 44, Ill.*

CIRCLE 258 ON READER-SERVICE CARD

SUB-MINI SOLENOID VALVES

New B Series sub-miniature Solenoid Valves for use in hydraulic and pneumatic devices and control systems operate with differential pressures from a vacuum of 5 μ to pressures of 150 psi. Three-way NC valves now available from stock. Three-way NO directional control and two-way NO and NC valves will be available shortly.—*Skinner Electric Valve Div., New Britain, Conn.*

CIRCLE 259 ON READER-SERVICE CARD

HIGH-VOLTAGE RECTIFIERS

New line of double diffused silicon high-voltage potted Rectifier Assemblies, is rated up to 50,000 peak reverse volts and 1 amp dc per block. Available in the widest range of configurations, with 1,000 standard sizes in single phase (half wave, center tap, or full wave) and three phase (half wave, full wave, or star) or in protective networks and tube replacements. Feature high reliability, miniaturization (up to 6,000 v in ¾" x ¾" x 1"), high surge ratings, operating and storage temperature range of 65°C to 150°C.—*Solitron Devices, Inc., 500 Livingston St., Norwood, N. J.*

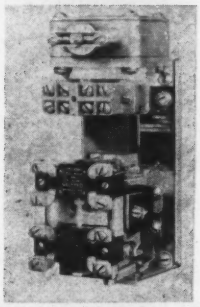
CIRCLE 260 ON READER-SERVICE CARD

ABSOLUTE PRESS TRANSDUCER

New Model 723 Absolute Pressure Transducer for use with corrosive media has 1% static error, uses special type 347 stainless steel isolation bellows that accepts corrosive, high pressure fluid or gas. Bellows action is transmitted through oil to precision spiral bourdon tube matched to potentiometer element. Range 0-350 0-3500 psia; resolution, 0.25 to 0.45%; power rating, 1.5 watts continuous at 165°F.—*Bourns, Inc.*, 6135 *Magnolia Ave., Riverside, Calif.*

CIRCLE 261 ON READER-SERVICE CARD

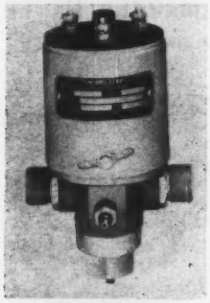
TWO-POLE TIMER



New Class 9050 Types B and C Timing Relays are now available with a new 2-pole snap switch. Timing is adjustable from 0.2 sec to 3 min, and contacts are totally enclosed. Available for both a-c and d-c operation.—*Square D Co., Dept. SA*, 4041 *N. Richards St., Milwaukee* 12, *Wis.*

CIRCLE 262 ON READER-SERVICE CARD

DRIVE UNITS



New GT-style Drive units mount directly on a standard 0.187"-shaft SAE tachometer take-off. In addition, they provide two wide take-offs for clockwise and counter-clockwise rotation. Auxiliary take-off shaft driven by precision right-angle helical gears at the same speed as the governor shaft. Ball and needle bearings are used throughout.—*Synchro-Start Products*, 8151 *N. Ridgeway Ave., Skokie, Ill.*

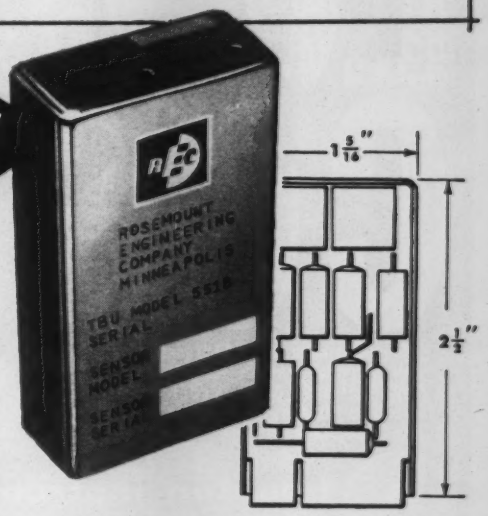
CIRCLE 263 ON READER-SERVICE CARD

Suppress lead wire error in resistance temperature measurement

with REC's

NEW

TRIPLE BRIDGE UNIT



The new Rosemount Triple-Bridge Unit suppresses the effects of variable unknown lead resistance better than any previous method used in variable resistance temperature measurement. Lead variation can introduce substantial errors, particularly where leads are unequal or lead resistance is unknown. The Rosemount TBU shows vastly better suppression of these errors than conventional 3-wire and 4-wire bridge circuits.

Check these advantages of this newly developed variation of the basic Wheatstone bridge:

- Suppresses large lead resistance changes (up to 5 ohms)
- Suppresses variable lead resistances both at null and when unbalanced
- Suppresses unequal lead resistances
- Can trim out calibration differences
- Multiple temperature ranges available at standardized output
- Standardized 10 mv. D.C. output to match existing equipment
- Complete selection of auxiliary equipment

The TBU is a precision-made, plug-in unit permitting convenient change of full-scale temperature and capable of correcting known calibration errors of the temperature probe used. A basic 10-channel Triple-Bridge Unit is offered, with sockets and inter-connecting wiring for 10 sensors and 10 plug-in TBU's, thus providing 10 temperature ranges for each sensor.

WRITE FOR BULLETIN 86012. It gives specification detail and a mathematical analysis of the increased accuracy possible with the Triple-Bridge Unit as compared with conventional 3-wire and 4-wire bridges.

ROSEMOUNT
ENGINEERING
COMPANY

4900 West 78th Street, Minneapolis 24, Minnesota

SPECIALISTS IN TEMPERATURE AND PRESSURE MEASUREMENTS

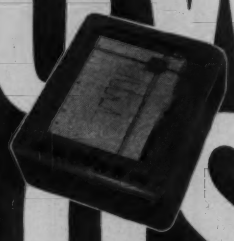
CIRCLE 103 ON READER-SERVICE CARD

X-Y RECORDER

Model HR-92

Unconditionally Guaranteed For One Year

LOW COST



Rugged, simple (8½"x11") plotter contains all essential features for 95% of all X-Y applications. Basic Model HR-92-1 is $595.00 (USA) with 10mv/in. sensitivity, ½% accuracy.

Write for bulletin 792-4.

houston instrument corporation

Box 22234 • Houston 27, Texas MO 7-7405

CIRCLE 104 ON READER-SERVICE CARD

A. D. JONES OPTICAL WORKS

2400 MASSACHUSETTS AVENUE

CAMBRIDGE 40 MASSACHUSETTS

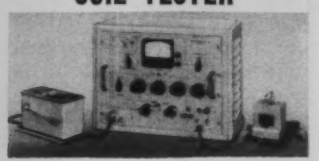
TRowbridge 6-3368—3369

People usually associate Optics with glass only. The following materials, successfully processed here by sawing, grinding and polishing or drilling are of value to designers, engineers and manufacturers. Most materials are supplied by our customers for their orders.

ALUMINA
ALUMINUM
ARSENIC TRISULPHIDE
BARIUM TITANATE
BRASS
CALCIUM TUNGSTATE
CARBORUNDUM
CERAMIC
COBALT FERRITE
COPPER
CORNING 707
CORNING 7052
FERRITE
FERROX
FLUORIDE, CALCIUM
FLUORIDE, LITHIUM
GALLIUM ANTIMONIDE
GARNET
GERMANIUM
GOLD
INDIUM ANTIMONITE
INDIUM PHOSPHIDE
INDOX
IRON SINGLE CRYSTAL
LITHIUM FERRITE
MAGNESIUM STANIDE
NICKEL OXIDE
NIOBIUM
PLATINUM
POTASSIUM BROMIDE
PYREX
QUARTZ, CRYSTAL
QUARTZ, FUSED
SAPPHIRE
SILICON
SODIUM CHLORIDE
STEEL
STRONTIUM TITANATE
TEFLON
TITANIUM DIOXIDE
VYCOR
X-RAY LEAD GLASS
VANADIUM

CIRCLE 105 ON READER-SERVICE CARD

COIL TESTER



New Maxim Coil Tester, measures the number of turns on coils with or without ferromagnetic cores with 0-1% accuracy and detects shorted turns.—*Maxim Controls Co.*, 4734 *N. Albina Ave., Portland, Ore.*

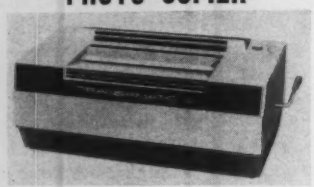
CIRCLE 264 ON READER-SERVICE CARD

ELECTRICAL INSTRUMENT

New 1½" Meter, Model 15LP, features a core-magnet movement, and is made with either clear or black finished acrylic case. Available in a wide variety of stock d-c and a-c ranges.—*Pace Electrical Instruments Co.*, 70-31 84*th St., Glendale* 27, *N. Y.*

CIRCLE 265 ON READER-SERVICE CARD

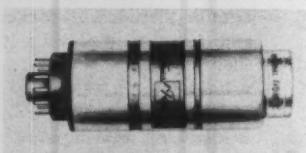
PHOTO COPIER



New Photocopier, the Transamatic I, features new disposable cartridge using completely pre-mixed developer. Reproduces a letter in 11 seconds on black, white, or a variety of colored papers. Bulletin gives details.—*Transcopy, Inc.*, 10 *Paterson Ave., Newton, N. J.*

CIRCLE 266 ON READER-SERVICE CARD

DETECTOR-PHOTOMULTIPLIER



New Series NRM Detector-Photomultiplier Tube assemblies have scintillating detector mounted directly to the photomultiplier tube and are hermetically sealed. Offered with NaI (Tl) detectors, Stilbene, Anthracene, enriched Li^6F-ZnS(Ag) and ZnS(Ag) detectors.—*National Radiac Inc.*, 475 *Washington St., Newark* 2, *N. J.*

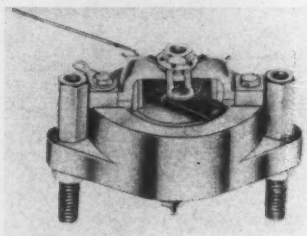
CIRCLE 267 ON READER-SERVICE CARD

SEAMLESS TUBING

New 300 Series 1 tubing has ultra-thin walls of 0.0005". Made as precision tubing in diameter sizes from 0.010" to 0.375" OD with tolerances of ±0.00005". Offered in Types 304, 310, 316, 321 and 347 stainless steel.—*Uniform Tubes, Inc., Collegeville, Pa.*

CIRCLE 268 ON READER-SERVICE CARD

MAGNET METERS

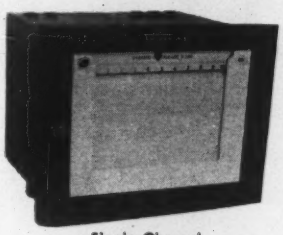


New series of 1½" to 7" true-core Magnet Meters incorporates self-shielding designs and features full double-bridge D'Arsonval movement with soft-iron pole pieces; exceptionally high torque to mass ratio; and small, light meter movements. Available in a wide variety of d-c voltage and current ranges as well as rectifier a-c types, including VU meters in either acrylic or phenolic case styles. —*Pace Electrical Instruments Co.*, 70-31 84*th St., Glendale* 27, *N. Y.*

CIRCLE 269 ON READER-SERVICE CARD

Here! The Utmost in Reliable

POTENTIOMETRIC RECORDERS



Single Channel
Multi (2-12) Channel

no slide wire!

The New Leader In Potentiometric Recording

- All Solid state (zener diode) power source ends standardizing annoyance
- Simple servicing: Main assembly swings out for easy access to all components
- Full Scale Deflection Time: 1 sec., 2½ sec., or 10 sec. (various models).
- Min. input range for FSD: 0-1 mV-dc (Directly records wide variety of transducers).

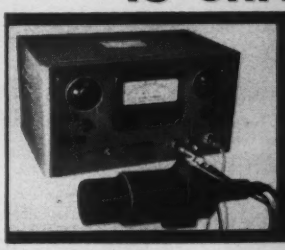
Many more outstanding features... write for FREE Catalog!

KELVIN & HUGHES America Corp.

P.O. Box 1951 — Annapolis, Maryland
105-23 Eastern Ave. — COlonial 7-8103

CIRCLE 106 ON READER-SERVICE CARD

WHERE HEAT CONTROL IS CRITICAL



PYROTEL RADIATION PYROMETER

MONITORS, CONTROLS PRECISELY

Instantaneous, accurate temperature readings on even inaccessible, moving or fragile objects are now possible with non-contacting **PYROTEL** infrared radiation pyrometer.

Operable, precise and dependable at distances from 1 inch to 100 feet or more, **PYROTEL** offers perfect control in heating processes. **PYROTEL** gives meter indication, recording output and relay and load controls

Models for all temperature ranges from 140°F up have proven extremely dependable and profitable in an unusually wide variety of applications. These include extrusion, hot forming, web drying, forging, heat treating, melting, hardening and other processes.

Write for complete information.

MASON INSTRUMENT COMPANY, INC.

222 Valley Place, Mamaroneck, N. Y.

CIRCLE 107 ON READER-SERVICE CARD

DC AMPLIFIER

New Type 98 d-c Amplifier is chopper-stabilized vacuum tube type, isolates recorder from signal source. Used with Rustrak 100 μ/a recorder, over-all amplifier sensitivity is 1 mv full scale; connected to standard 1-mil recorder, unit provides multitude of measurements, including temperature with low output thermocouples.—*Rustrak Instrument Co.*, 130 *Silver St., Manchester, N. H.*

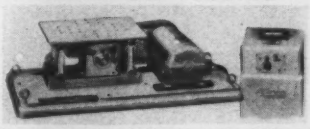
CIRCLE 270 ON READER-SERVIC ECARD

COUNTER-TIMER

New electronic Counting and Timing Device can split a second into more than 100,000,000 slices and make frequency and timing measurements of events occurring at speeds approaching that of a beam of light. If used as part of an airport radar, it would enable operator to tell exact position of an approaching airplane with a margin of error of less than 4 ft at a distance of 10 miles. A ground-level application of the radar principle would be in surveying, measuring distances quickly and accurately.—*Computer Measurements Co., Sylmar, Calif.*

CIRCLE 271 ON READER-SERVICE CARD

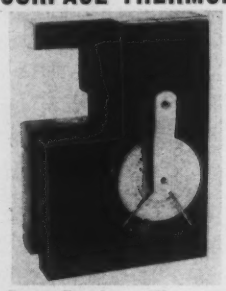
VIBRATION TESTING



New Model 150-HLAT Vibration Fatigue Testing Machine subjects equipment to extremes of horizontal vibration through band of 5 to 100 cps. Acceleration and deceleration are electronically controlled.—*All American Tool and Mfg. Co.*, 8017 *Lawndale Ave., Skokie, Ill.*

CIRCLE 272 ON READER-SERVICE CARD

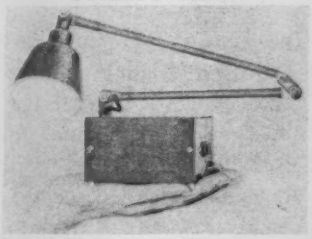
SPOT SURFACE THERMOMETER



New Spot Surface Thermometer is made in five ranges: from 50 to 1000° F, 0-270° F. Calibration is within ±2%.—*Pacific Transducer Corp.*, 11836 *W. Pico Blvd., Los Angeles* 64, *Calif.*

CIRCLE 273 ON READER-SERVICE CARD

UTILITY LAMP



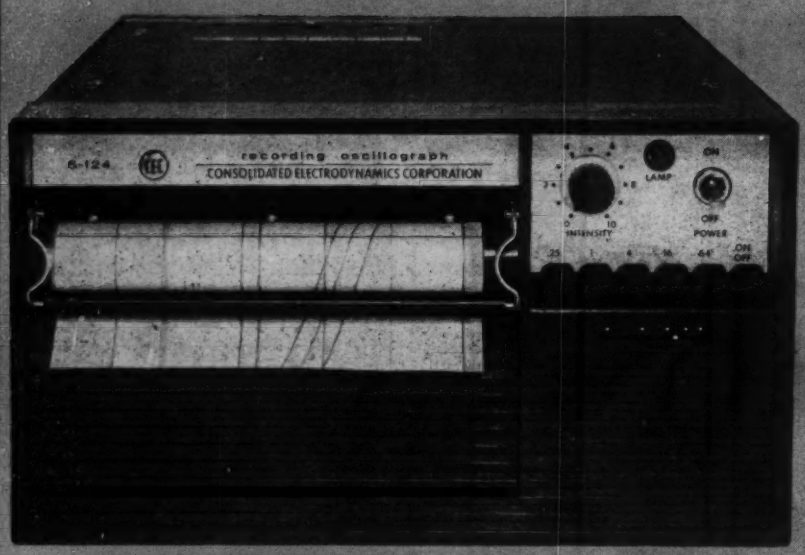
New fold-away Utility Lamp, uses standard GE 1130 bayonet type bulb for 150-foot-candle intensity at a distance of 12" from the lamp to object.—*Tensor Electric Development Co., Inc.*, 1873 *Eastern Parkway, Brooklyn* 33, *N. Y.*

CIRCLE 274 ON READER-SERVICE CARD

SOLENOID VALVES

New encapsulated moisture-proof Solenoid Valve, Series 10, can be supplied wtih rectifier diodes molded into the unitized magnetic circuit to operate as d-c units from an a-c source. They do not increase the valve size at all.—*Peter Paul Electronics, Inc.*, 251 *Whiting St., New Britain, Conn.*

CIRCLE 275 ON READER-SERVICE CARD



Inside this portable recording oscillograph...

A FOCUSED PRECISION OPTICAL SYSTEM TO ASSURE HIGHEST TRACE RESOLUTION

The high-efficiency optical system of CEC's 5-124 Recording Oscillograph concentrates more high actinic light on the record... permits a writing speed of 50,000 ips with trace widths of 0.010" or less.

Optics are specially treated for higher light transmissibility. This means "big" oscillograph capability in a portable, low-cost instrument. The 5-124 easily records and resolves phenomena occurring in intervals as short as 500 microseconds... boasts 18-channel capacity... delivers ready-to-read print-out records that eliminate processing problems.

Among the 5-124's standard features are pushbutton control, intensity control, unexposed footage indicator, individual input connectors and automatically regulated galvanometer lamp circuit. These optional features are available: grid lines (1/10" or mm), trace identification and numbering, full-width timing lines and galvanometer block heaters.

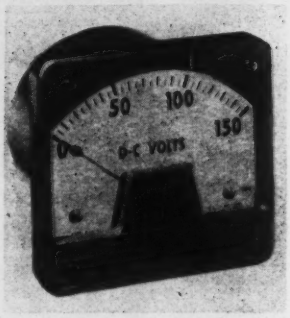
For complete information, call your nearest CEC sales and service office or write for Bulletin CEC 5124-X15.

Data Recorders Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

A SUBSIDIARY OF Bell & Howell · FINER PRODUCTS THROUGH IMAGINATION

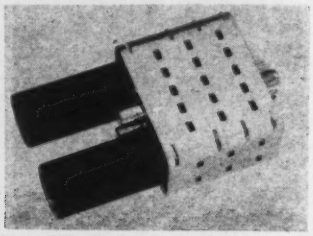
SWITCHBOARD INSTRUMENTS



New low-priced Switchboard Line, Type K-221, featuring taut-band suspension, stands severe vibration and shock without loss of accuracy. Line includes a-c and d-c ammeters and voltmeters, wattmeters, varmeters, and frequency meters. D-c instruments, using core-magnet construction, are shielded against external magnetic fields. They can be mounted within two inches of a bus carrying 10,000 amp with less than ½% effect on their indication.—*Westinghouse Electric Corp., Box* 2099, *Pittsburgh* 30, *Pa.*

CIRCLE 276 ON READER-SERVICE CARD

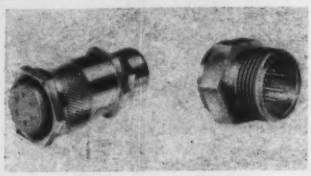
OPERATIONAL AMPLIFIER



New SK2-V high-performance Differential Operational Amplifier features high reliability, speed, and precision. Performance characteristics: 100,000 open-loop gain at dc, unity open loop gain at 1 Mcps, ±50 v balanced differential inputs, and up to 3 ma output at ±100 v.—*Philbrick Researches, Inc.*, 127 *Clarendon St., Boston* 16, *Mass.*

CIRCLE 277 ON READER-SERVICE CARD

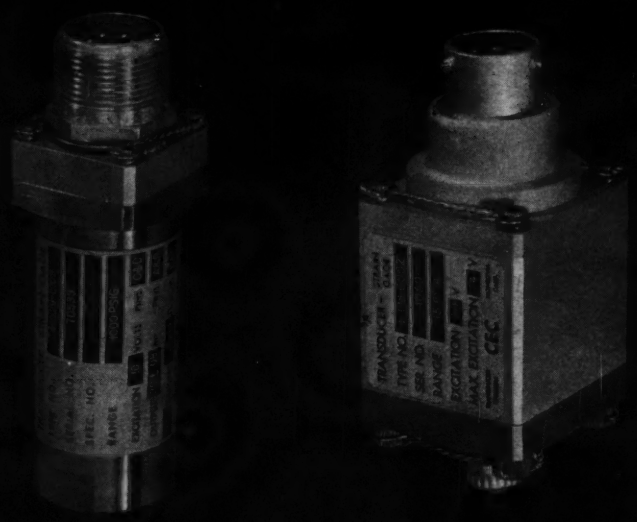
HERMETIC-SEAL CONNECTORS



New hermetic-seal Connectors for high-temperature and high-reliability requirements feature all-stainless steel construction. Plugs and receptacles carry #20 contacts in 5 insert arrangements. Can be operated at 800° F to 1 x 10^{-20} NVT without loss of seal or major change in electrical properties.—*Physical Sciences Corp., Affil. Packard Bell Electronics,* 389 *North Fair Oaks Ave., Pasadena, Calif.*

CIRCLE 278 ON READER-SERVICE CARD

←CIRCLE 108 ON READER-SERVICE CARD



High range . . . low range–

BOTH OF THESE NEW CEC PRESSURE TRANSDUCERS FEATURE BUILT-IN SHUNT COMPENSATION

These new strain gage units are the most accurate and highly sophisticated pressure transducers ever built for rugged airborne use. They were designed to outperform every known similar type of instrument . . . and they do.

Their shunt calibration feature permits the system designer to provide—quickly and simply—a complete calibration of his data handling system for precise control of associated equipment.

Type 4-328 (square) is a low-range unit for pressure ranges of 0-15 psi through 0-99 psi absolute. Standard ranges are 0-15, 20, 30, 50 and 75 psi absolute. **Type 4-329** (tubular) is a high-range unit for pressure ranges of 0-100 psi through 0-5000 psi absolute. Standard ranges are 0-100, 150, 250, 500, 1000, 1500, 2500 and 5000 psi absolute.

Here are some of the specifications they have in common:

Rated electrical excitation: 20v dc or ac rms; carrier frequency 0-20 kc.

Sensitivity: 50 mv ±0.25 mv into a 50k load at rated excitation and 77°F.

Compensated temperature range: +30°F. to +250°F.

Weight: 5.5 oz. max. exclusive of mating electrical connector.

Input impedance: 700 ohms minimum.

Output impedance: 350 ohms ±10% at 77°F.

Shunt output: 33,270 ohms keyed across negative input and negative output pins at zero applied pressure, rated excitation, and 77°F., produces an electrical output change equal to the sensitivity within a tolerance of ±0.355%.

For more information and complete specifications, call your nearest CEC sales and service office or write for Bulletin CEC 4328-X1 or 4329-X1.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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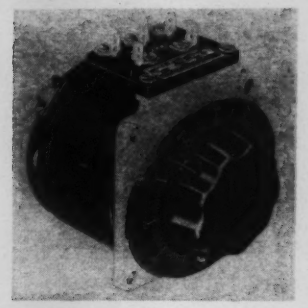
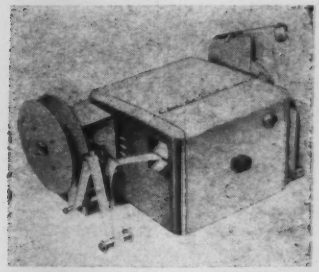
VARIABLE TRANSFORMERS



New 50/60 cycle Powerstat Variable Transformers Series 21, has output ratings up to 3.75 amp with constant current loads and up to 5.5 amp with constant impedance loads. It has zero waveform distortion with high efficiency, excellent regulation, and linear output voltage. Bulletin P6121 gives details.—*Superior Electric Co., Dept* 21, *Bristol, Conn.*

CIRCLE 279 ON READER-SERVICE CARD

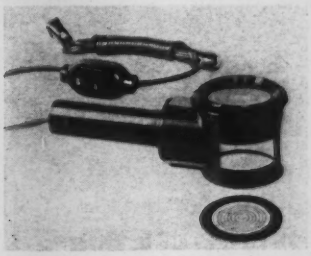
TAPE PUNCH



New multi-Magnet Tape Punch, Model 28, LARP, receives parallel-wire input from message communications equipment. Electromechanically operated, it provides programmed storage in fully perforated tape. Operating at 20 characters/sec, it is available for 5, 6, 7, or 8-level operation.—*Teletype Corp., Dept. SP-*14, 5555 *Touhy Ave., Skokie, Ill.*

CIRCLE 280 ON READER-SERVICE CARD

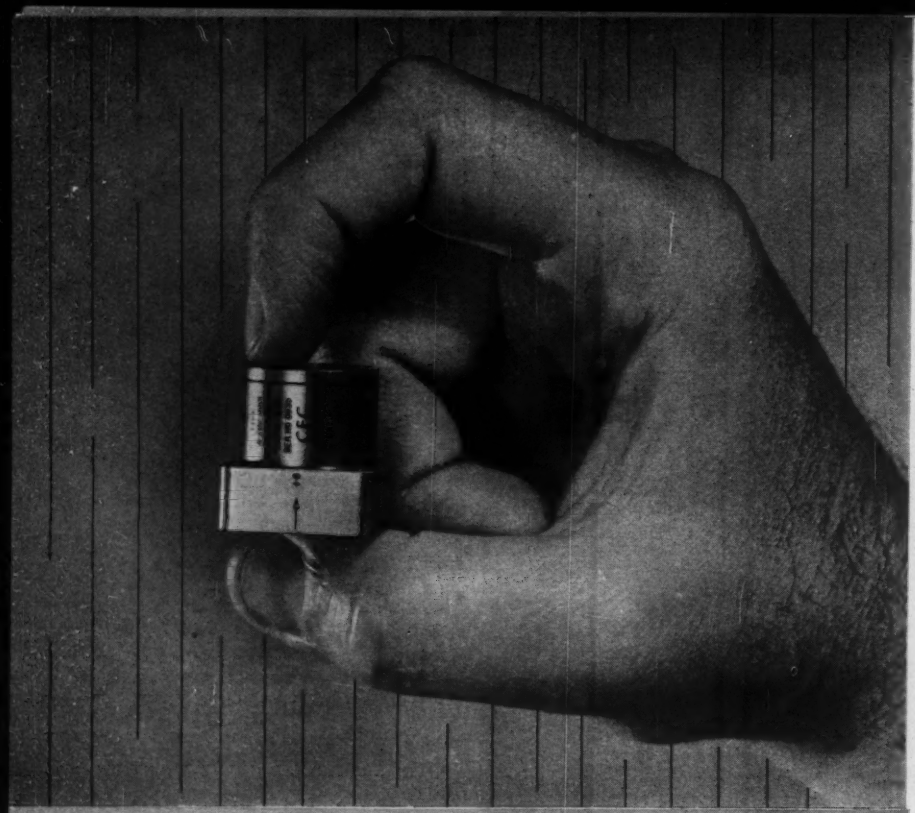
BATTLEY DISC ACCESSORY



New Battley Disc accessory to Flash-O-Lens illuminated magnifiers fits into the bottom housing of 5X and 7X models. Has series of concentric circles for fine inspection and identification work. Presently used by police and criminologists for finger print identification.—*E. W. Pike & Co., Inc.,* 711 *Pennsylvania Ave., Elizabeth, N. J.*

CIRCLE 281 ON READER-SERVICE CARD

←CIRCLE 109 ON READER-SERVICE CARD



Measuring perpendicular accelerations?

Look forward to spectacular performance from this tiny strain gage accelerometer! It's CEC's Type 4-202, the smallest temperature compensated instrument on the market.

Designed to measure accelerations perpendicular to mounting surfaces, it is available in a range of ±5g to ±500g.

These performance characteristics prove the 4-202 superior to any other linear unbonded strain gage bi-directional accelerometer: unusually low cross axis response... unusually high resonant frequency... extremely little damping change over a temperature range of –65°F. to +250°F.

For complete information, call your nearest CEC sales and service office or write for Bulletin CEC 4202-X11.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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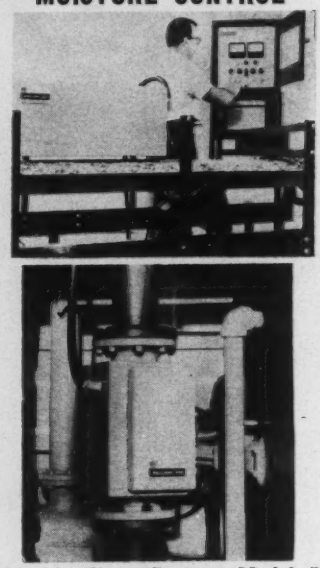
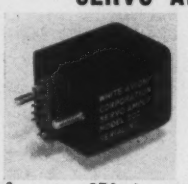
MOISTURE CONTROL



New Qualicon System, Model 507, measures and controls percent moisture of solid materials on a belt or in a storage facility. Consists of three basic parts: measuring head, electronic read-out, and recorder/controller. Can be provided with either analog or digital data presentation and control. Based on neutron reflection.—*Nuclear-Chicago Corp., 359 East Howard Ave. at Nuclear Drive, Des Plaines, Ill.*

CIRCLE 282 ON READER-SERVICE CARD

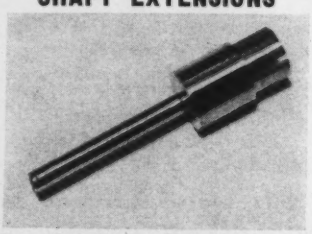
SERVO AMPLIFIER



New Model 500 miniature solid-state Servo Amplifier drives a center-tapped size 11 servo motor. Features gain of 2500; stability ±3db from −65° to +125°C, ±2db from −35° to +125°C; input impedances of 10,000 ohms to ½ megohms. No external heat sinks required.—*White Avionics Corp., Terminal Rd., Plainview, L. I., N. Y.*

CIRCLE 283 ON READER-SERVICE CARD

SHAFT EXTENSIONS

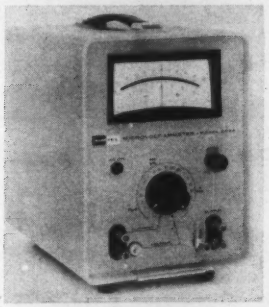


New Precision Shaft Extensions, available from stock, are precision machined from #303 stainless steel, with clear passivated finish, in ⅛", $\frac{3}{16}$" or ¼" shaft sizes. Furnished with same size male and female ends, or in any combination of these sizes. —*PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.*

CIRCLE 284 ON READER-SERVICE CARD

←CIRCLE 110 ON READER-SERVICE CARD

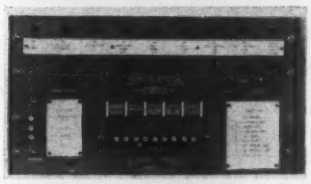
MICROVOLT-AMMETER



New Model 203A D-c Microvolt-Ammeter and Amplifier, providing full scale ranges from 100 uv to 1000 v and 1 mu amp to 1 amp, consists of an input divider followed by a chopper amplifier and a two-stage, direct-coupled meter driver amplifier. Accuracy is ±3% of full scale. Maximum gain as an amplifier is 80 db.—*Kin Tel, Div. Cohu Electronics, Inc., 5725 Kearny Villa Rd., Box 623, San Diego 12, Calif.*

CIRCLE 285 ON READER-SERVICE CARD

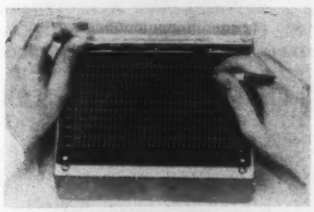
SUPERVISORY CONTROL



New solid-state Supervisory Control System, MARC IX, for electric power sub-stations, pipelines, etc., is a step control system requiring (1) station and function selection, (2) code lock of remote operation function to prevent false control, and (3) command; with verification after each step before a control command is executed. Control signals are transmitted binary code.—*Moore Associates, Inc., 893 American St., San Carlos, Calif.*

CIRCLE 286 ON READER-SERVICE CARD

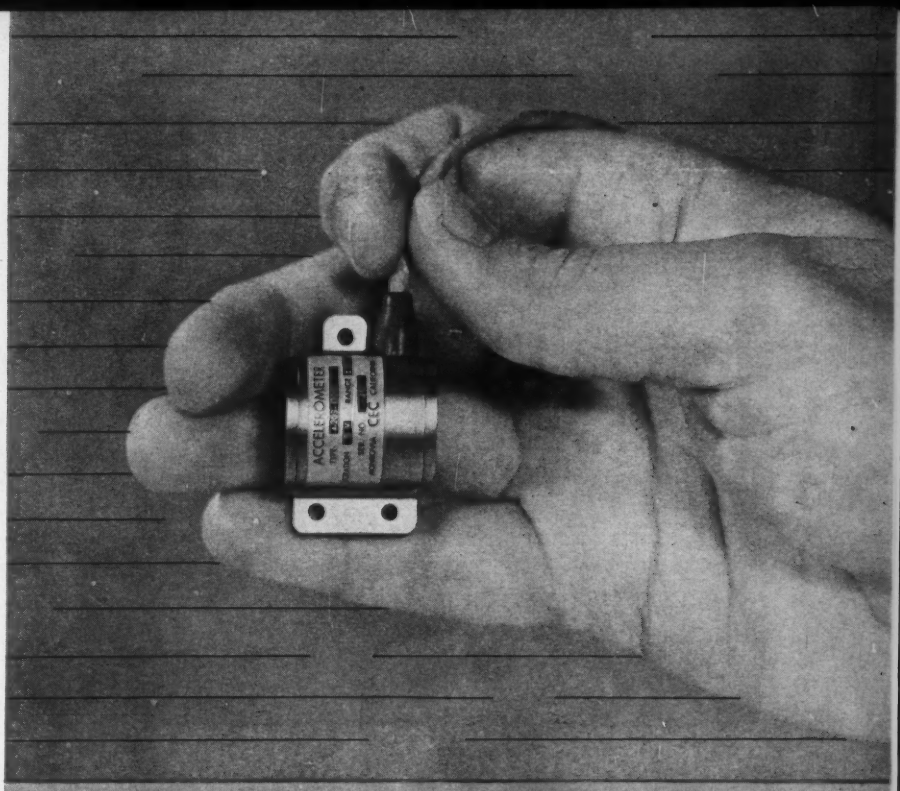
FUNCTION GENERATOR



New D-c Adjustable Function Generator, Model DC250, an adjustable nonlinear potentiometer, provides nonlinear output with shaft rotation of an associated interpolating vernistat. Can program and control any process or operation which is a function of shaft position or time. Any nonlinear function, even functions with multiple slope reversals, can be generated.—*Perkin-Elmer Corp., Norwalk, Conn.*

CIRCLE 287 ON READER-SERVICE CARD

CIRCLE 111 ON READER-SERVICE CARD→



Measuring parallel accelerations?

Count on sensational performance from the newest addition to CEC's family of strain gage accelerometers! Type 4-203 packs all the superior performance characteristics of earlier models into just one cubic inch and less than three ounces.

Available in ranges from ±5g to ±500g, the 4-203 operates in a temperature range of –65°F. to +250°F.

In accurately measuring accelerations parallel to mounting surfaces, this miniature instrument performs with the lowest cross axis response... the smallest damping change with temperature... and the highest resonant frequency of any comparable instrument available.

For complete information, call your nearest CEC sales and service office or write for Bulletin CEC 4203-X6.

Transducer Division CEC

CONSOLIDATED ELECTRODYNAMICS / pasadena, california

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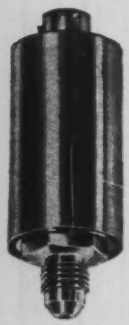
A Transducer Two Years Ahead of its Time



A completely new patented pressure sensor concept has been utilized in Servonic's new, low pressure L-96 Transducer. This miniature potentiometer-type unit withstands vibration levels in excess of 35 g's with less than 1% error. Two separate sets of aneroid capsules attached to opposite ends of a driving frame are utilized in the design. One set senses the driving media while the second can be evacuated for an absolute pressure reference, or vented to the atmosphere for gage measurement.

Pressure changes are transmitted through a unique, frictionless, metallic belt linkage system to position the wiper of the precision potentiometer. The fluid filled interior dampens vibration effect, provides long life and minimizes electrical noise. The unit is so insensitive to vibrations, extended dwells are allowed at any vibration frequency. Besides its excellent vibration characteristics, the L-96 has a temperature range of −65° to 275° F and a range of 0-15 to 0-350 psia or g.

For additional information about the wide pressure ranges and mounting configurations available in the L-96, write:

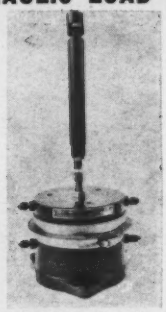
SERVONIC INSTRUMENTS, INC.

Manufacturers of pressure transducers, pressure switches, rectilinear potentiometers and slip ring assemblies.

1644 WHITTIER AVENUE, COSTA MESA, CALIFORNIA

CIRCLE 112 ON READER-SERVICE CARD

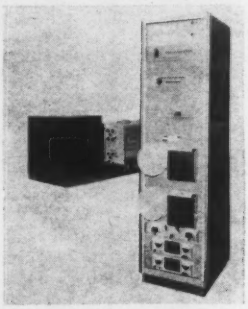
HYDRAULIC LOAD CELL



New Hydraulic Load Cell, Type ADR-1, designed for use with dynamometer measures tension or compression loads. Essentially a piston-cylinder assembly using a long-stroke molded diaphragm, it has output hydraulic pressure directly proportional to applied load. Indicator has three sets of numbers to give load ranges of 0 to 200 lb (compression); −100 to 0 to +100 lb; and −200 lb (tension) to 0 lb.—*A. H. Emery Co., Pine St., New Canaan, Conn.*

CIRCLE 288 ON READER-SERVICE CARD

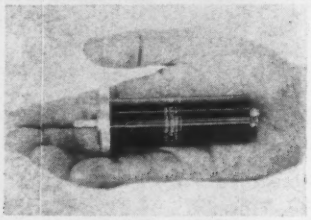
PATTERN CONVERTER



New Pattern Converter converts any display such as oscilloscope, map, or chart to digital language. Originally developed to convert weather radar echo patterns on a PPI scope to a digital record on punched tapes, it can be modified to convert any analog display to magnetic tape, drums, or punched cards. Bulletin gives details.—*Rabinow Engineering Co., Inc., 7212 New Hampshire Ave., Washington 12, D. C.*

CIRCLE 289 ON READER-SERVICE CARD

TACHOMETER GENERATOR



New 45-volt/1000 rpm Tachometer Generators, Model SU-780D-1, features a stainless steel shaft of $\frac{1}{16}$" dia and an outer shaft bearing fitted with a neoprene seal.—*Servo-Tek Products Co., 1086 Goffle Rd., Hawthorne, N. J.*

CIRCLE 290 ON READER-SERVICE CARD

Look to September 1961 issue of Instruments and Control Systems for expert treatment of this important control topic - - -

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ICS' READERS can look forward to a comprehensive display of highly informative and useful data.

MANUFACTURERS and designers of associated instrumentation, equipments and components will find this a particularly valuable medium in which to advertise.

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---

for more data on products advertised or reported editorially

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2. **PRINT YOUR NAME, title, company, address, etc. clearly. Unreadable cards defy even punched card machines!**

NOTE: If indicating change of address, be sure to also show OLD address.

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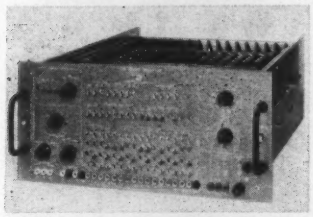
7/61

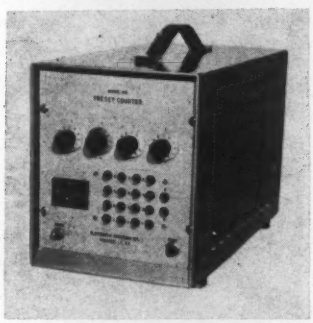
SIGNAL SIMULATOR



New Signal Simulator Model 208A which provides PCM signals for checkout, calibration, or evaluation of PCM telemetry equipment such as the Model 185 Digital Decommutator, tape storage and handling systems, formatting equipment, etc. and associated digital telemetering equipment, can simulate various errors which may be encountered under actual operating conditions. Transistorized; mounted in standard 19" rack. —*Electro-Mechanical Research, Inc., Sarasota, Fla.*

CIRCLE 291 ON READER-SERVICE CARD

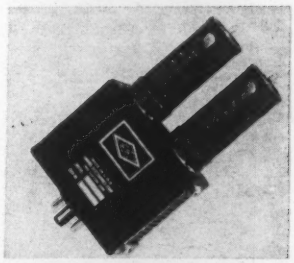
PRESET COUNTER



New solid-state, single-sequence, Preset Counter, Model 145, has 4-BCD counting decades for data and control system compatibility. Versatile inputs and outputs are featured with input frequency response to 50 kc.—*Electronic Counters, Inc.*, 155 *Eileen Way, Syosset, L. I., N. Y.*

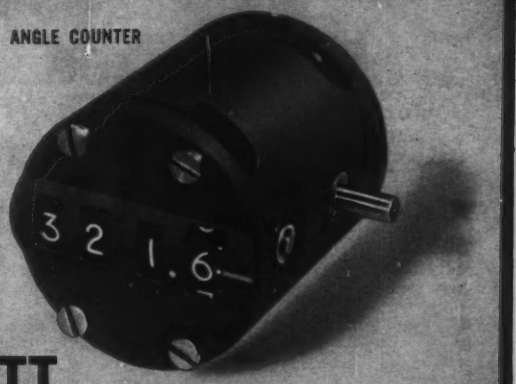
CIRCLE 292 ON READER-SERVICE CARD

BOOSTER AMPLIFIER



New cathode-follower Booster Amplifier provides output from −100 vdc to +100 vdc from a high impedance input signal. Can be operated continuously at full output rating of 30 mamp at maximum output voltage. Input power required is ±300 vdc.—*Embree Electronic Corp., West Hartford, Conn.*

CIRCLE 293 ON READER-SERVICE CARD



KEARFOTT NAVIGATIONAL COUNTERS

Direct visual counter display provides the advantage of enabling lower valued increments of various angles to be easily read in terms of minutes and seconds of arc by means of relatively large size numerals. This advantage is achieved without the necessity of having vernier dials or similar devices. These counters are precision designed and their rugged construction assures a long life of trouble free service. B422 units are provided with either odometer or Geneva drives, while MK II units use Geneva drives. Gears, wheels, housings, and mounting flanges are constructed of durable materials, and Kearfott design techniques provide maximum readability in a relatively small amount of space. Kearfott counters operate reliably throughout a temperature range of −65°C to +90°C and meet the military requirements for shock, vibration, and case size.

FEATURES: ▪ Long Operational Life ▪ Compact Design ▪ High Speed ▪ Lightweight

CHARACTERISTICS:

All Counters Below Incorporate Geneva Drive

TYPE	PART NUMBER	NO. OF DIGITS	MAXIMUM COUNT	COUNTS PER REV.	MAXIMUM SPEED RPM	MAXIMUM BREAK AWAY TORQUE @ 20°C
B422 SERIES:[1]						
ANGLE	B422-□[2]	5	179° 59′	20′	1200	.75
(center scale)	C160432-□	5	179° 59′	20′	1200	.75
	C160431-□	6	179° 59.9′	2′	1200	1.0
	C160435-□	4	179.9°	2°	1200	.75
DECIMAL	C160433-□	3	99.9	2.0	1200	.75
(center scale)	C160434-□	4	999.9	2.0	1200	.75
MK II	MK 2 MOD 1	4	359.9	2.0°	1800	.35
Mod I	MK 3 MOD 1	3	359.	2.0°	1800	.35
SERIES:	C1604070004[3]	4	359.9	2.0°	1800	.35
	A403-20B	4	359.9	2.0°	1800	.35

[1] Available in left or right Shaft, End or Side Mount, Mask readout of N-S, E-W, (+), (—)

[2] Same as C160432-□ except .040 shorter length (C160432 preferred for new designs)

[3] Available in various shaft extensions and white or bare aluminum numerals

Write for complete data

KEARFOTT DIVISION
GENERAL PRECISION, INC.

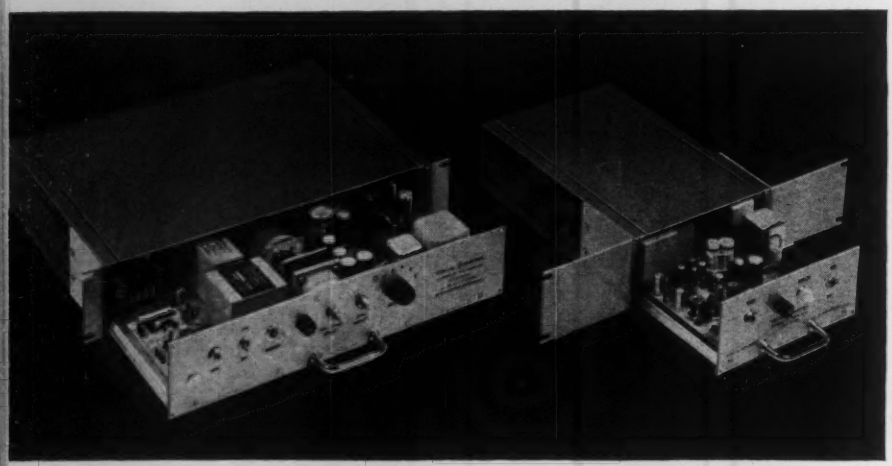
Little Falls, New Jersey

CIRCLE 113 ON READER-SERVICE CARD

NEW GENERAL ELECTRIC

Transistorized Analog

FREQUENCY TELEMETERING OFFERS GREATER SPEED OF RESPONSE, INCREASED ACCURACY



Now available! General Electric's all-new Analog Frequency Telemetering System provides greatest possible *FLEXIBILITY* to meet utility load dispatching and industrial data transmission applications.

Universal design can be easily modified for varying applications resulting in system simplicity and flexibility. Manufacturing standardization assures quick delivery.

Optional plug-in audio-tone equipment permits transmission of data over voice or microwave channels where tone frequencies are required. Optional tone transmitter and receiver offer forty different tone frequencies available with conventional shift-type operation.

Completely transistorized system has *no* vacuum tubes. Telemeter transmitter, tone transmitter and receiver use only transistors in their circuitry. Telemeter receiver utilizes only diodes.

Compact System rack mounts—conserves valuable panel space.

Plug-in application adapters determine input range and output signals for both the transmitter and receiver. Plug-in filters and transformers select tone frequencies.

Combined accuracy of transmitter and receiver is ±0.5 percent of full span over these variations: ± 15°C temperature, ± 5 percent voltage change, ± 3 cycles frequency. A combined accuracy of ± 1 percent of full span is assured even when the transmitter is subjected to −20 to 55°C or ± 10 percent voltage change.

System stability—±0.5 percent of full span in six months plus ±0.1 percent of full span per each subsequent six months.

Quick response—system speed of response is rated 1 second for 99 percent of scale range—practically instantaneous. Such response is invaluable in applications involving load-frequency control wherein high-speed response is essential. In addition, there is no overshoot.

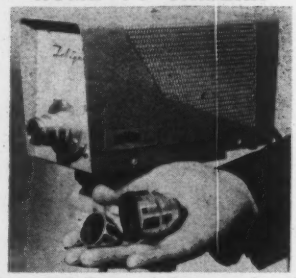
For utility telemetering in transmitting rapid fluctuation of electrical quantities such as watts, vars, volts and amperes . . . for fast positive transmission of industrial process data including quantities of pressure, temperature, liquid level, flow and many others . . . check into the cost saving advantages of G.E.'s new Analog Frequency System today. Your nearest G-E sales representative will be glad to provide you with additional information on this all-new low cost system. Be sure to ask for bulletin GEA-7163, or write direct to General Electric Company, Section 599-07, Schenectady 5, N. Y.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 114 ON READER-SERVICE CARD

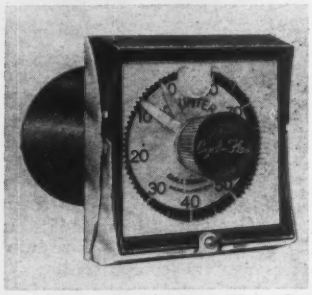
HOME TV CAMERA



New Tel-Eye miniature closed-circuit television camera uses existing receivers as monitors. Almost completely transistorized circuitry provides high-definition pictures with extremely good contrast characteristics. Self contained, it attaches to a-c outlet and by coaxial connector to television receiver. Basic type TC-110 has 300-line resolution. Type RC-110V, for use with a professional television monitor, has 400-line resolution.—*Industrial Television Dept., Allen B. Du Mont Labs., Divs. of Fairchild Camera and Instrument Corp., 750 Bloomfield Ave., Clifton, N. J.*

CIRCLE 294 ON READER-SERVICE CARD

IMPULSE COUNTER



New Bulletin-725 Cycl-Flex Counter includes two SPDT 5-amp delayed switches which trip at the end of a preset count. Another switch is operated instantly by the clutch coil at the beginning of the count. Reset time is ⅓ sec, accomplished electrically by the clutch solenoid. Maximum count speed is 400 counts/min.—*Eagle Signal Co., Div. Gamewell Co., E. W. Bliss Co., Subs., 202-20th St., Moline, Ill.*

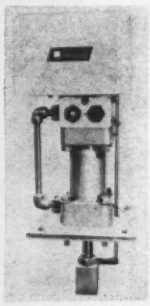
CIRCLE 295 ON READER-SERVICE CARD

REMOTE ALARM

New Model 901 "Alertra" solid-state Remote Alarm Monitor samples and encodes any number of data points and keys a single channel of any transmission medium. Signal is decoded and displayed at receiver; operation is continuous over microwave, UHF, VHF, or telephone line. Bulletin 901.—*CompuDyne Corp., Hatboro, Pa.*

CIRCLE 296 ON READER-SERVICE CARD

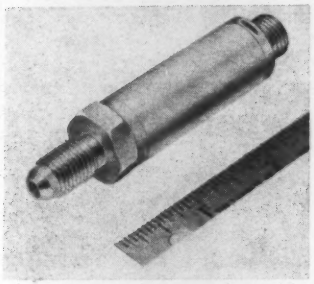
VALVE ACTUATOR



New Valve Actuator for atomic reactor power plants is based on analog-computer control system simulation permitting all performance parameters to be thoroughly checked out prior to the mechanical design stage. Delivers 50,000 lb force in either direction in 0.3 sec to operate a 12" valve against steam pressures of 550 psig.—*CompuDyne Corp., Hatboro, Pa.*

CIRCLE 297 ON READER-SERVICE CARD

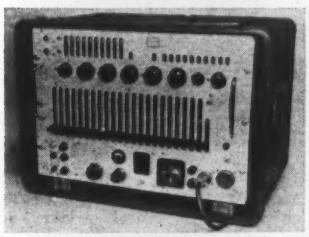
DIGITAL TRANSDUCERS



New solid-state Transducers measuring pressure, temperature flow, and acceleration have digital output without use of auxiliary equipment; and Subminiature Potentiometric Pressure Transducers, Switches and Indicating Meters, with static, dynamic and environmental performance characteristics superior to larger units, are described with specs in a set of six technical bulletins.—*Electronics Div., DeJur Amsco Corp.*, 45-01 *Northern Blvd., Long Island City* 1, *New York.*

CIRCLE 298 ON READER-SERVICE CARD

DIGITAL CLOCK



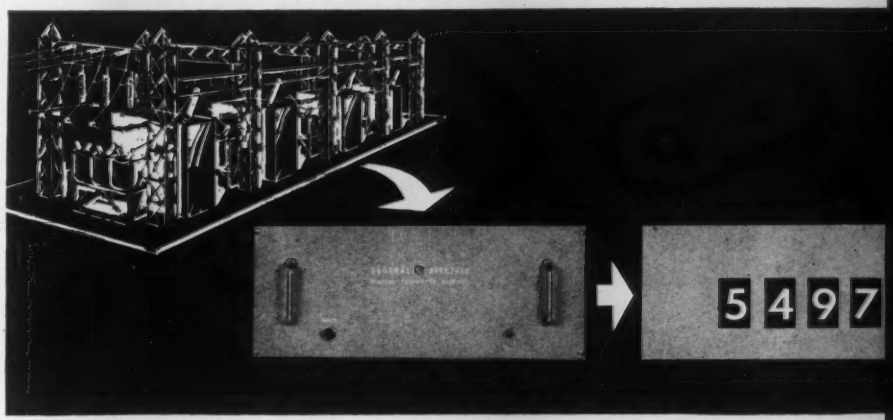
New Model 801 Digital Clock provides high accuracy solar or sidereal time. Combines precision crystal oscillator, parallel binary time register, WWV receiver and time synchronizer. Readout is in parallel binary bits by a digital computer or paper tape perforator.—*General Mills, Inc.*, 1620 *Central Ave., Minneapolis* 13, *Minn.*

CIRCLE 299 ON READER-SERVICE CARD

NEW GENERAL ELECTRIC

Digital Telemetering

SYSTEM FOR FAST,
HIGH ACCURACY
DATA TRANSMISSION



For fastest, most accurate utility load or billing information, General Electric's all-new Digital Telemetering System brings kilowatt-hour information into load dispatching office over one channel, with *100 PERCENT ACCURACY*. Offers outstanding system values . . .

Flexibility: Digital telemetering signal can be time-multiplexed with an analog telemetering signal at a preset time interval, thus providing minimum channel expense and lower operating costs. Or the digital telemetering system can be used over its own isolated channel to transmit information on command. This system will also operate over any intermediate channel equipment capable of accommodating standard analog "frequency" telemetering signals.

Accuracy: Digital receiver self-checking feature permits only the read-out of correct numbers.The receiver will cancel the readout if there has been an incorrect code or interference of the coded signal during transmission.

Speed: Digital transmission is in the form of long and short pulses at average rate of 10 cps. A six digit number can be telemetered in less than five seconds.

Design: System utilizes time-proved relays and stepping switches that require minimum maintenance. No tubes or transistors are used. Equipment is furnished in 19-inch rack, dust-proof cases with slide-out drawers.

Cost: System price is usually less than the cost of comparable integrating devices which it now obsoletes.

Various read-out devices are available depending on your requirements. These include: electric typewriter, visual digital display units and tape punch equipment if you wish to use the information in a digital computer. Digital transmitters and receivers can be provided for either 4, 6 or 8 digit numbers.

For additional information on the all-new G-E Digital Telemetering System, just call your nearest General Electric sales office, ask for a copy of bulletin GEZ-3312, or write direct to General Electric Company, Section 599-07A, Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company Ltd., 940 Lansdowne Avenue, Toronto 4, Ontario.

INSTRUMENT DEPARTMENT

GENERAL ELECTRIC

CIRCLE 115 ON READER-SERVICE CARD

EXTENDING MAN'S SENSES IN HIS ENVIRONMENT AND BEYOND!

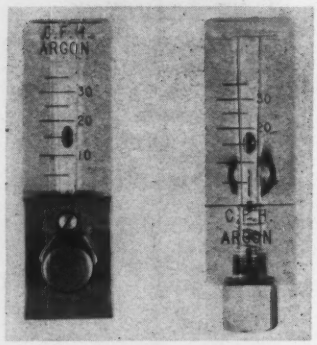
TOUCH

With our dynamic progress in the technological sciences . . . man's sensorial abilities have been relegated to a point of lesser importance. Instrumentation — many times more perceptive than our sense of "touch" — is paramount! Such instrumentation is evident in the Proximity Scorer — engineered and produced by Franklin Systems, Inc. The Scorer records near-misses of up to 30 feet of a towed target or drone. A projectile is tagged with a speck of radioactive material and when passing within a radius of the target, a hit is scored via a counter contained in the target.

FRANKLIN SYSTEMS
INCORPORATED
2734 HILLSBORO ROAD • WEST PALM BEACH, FLORIDA • TE 3-4602

CIRCLE 116 ON READER-SERVICE CARD

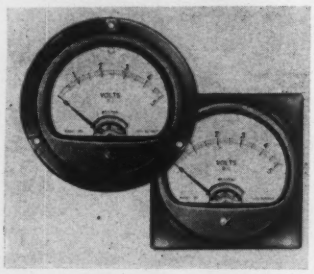
PURGE METERS



New custom line of Purge Meters fits minimum space requirements and can be modified for special purposes. Has "O" ring seals. Materials include acrylic plastic, metals, and glass. Maximum operating pressure is 100 psi. Capacities: from 0.01 to 90 scfh air, or 0.001 to 20 gph water. Bulletin 0100.—*C-Mar Sales Div., Chem Flow Corp.*, 117 *Paterson Ave., Little Falls, N. J.*

CIRCLE 300 ON READER-SERVICE CARD

PANEL METERS



New Model 201/301 Panel Instrument Series includes redesigned models of the 2½" and 3½" round and rectangular meters, available in d-c, r-f, a-c rectifier, and a-c moving-iron types with rated accuracy of 2% of full-scale value in all models except the rectifier type a-c series with a 3% value. All types in both models are now covered by three year warranty.—*Daystrom, Inc., Weston Instruments Div.*, 614 *Frelinghuysen Ave., Newark* 12, *N. J.*

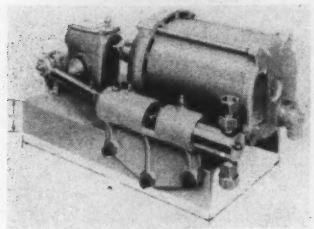
CIRCLE 301 ON READER-SERVICE CARD

ELECTROMETER

New Model E-302 Electrometer for gas chromatography, nuclear-reactor power plants, spectrometry, air pollution detection, gamma monitors, etc. features high speed and response time and exceptional stability. Multiplier switch can change ranges without causing transients due to switching high-meg resistors. Details in brochure.—*Gyra Electronics Corp., Washington & Elm Sts., Box* 184, *La Grange, Ill.*

CIRCLE 302 ON READER-SERVICE CARD

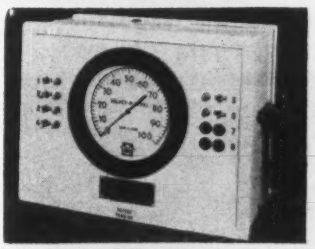
VARI-FLOW PUMP



New Vari-Flow Pump, to supply liquid to ARCCO Anubis Liquid Gravitometers from lines operating under unusually high pressures where no differential is available, is offered as Model GSP-HP1, a single-cylinder pump with output volume of 0 to 2000 cc/min; and Model GSP-HP2, a two cylinder pump, both for pressures up to 1000 psi and output volume of 0 to 4000 cc/min.—*ARCCO Instrument Co., Inc.*, 7144 *East Condor St., Los Angeles* 22, *Calif.*

CIRCLE 303 ON READER-SERVICE CARD

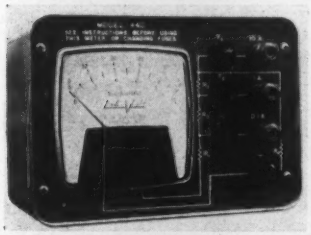
EIGHT TANK UNIT



New Select-O-Level, a remote indicating device for reading level of liquids in open tanks, uses selector switches for instantaneous readings of up to 8 and 16 tanks respectively. Pilot lights indicate what tank is being read. Can be located up to 500 ft from tanks, and reads level up to 33 ft.—*Barnard & Leas Mfg. Co., Inc.*, 1200-34 *Twelfth St., Southwest, Cedar Rapids, Iowa.*

CIRCLE 304 ON READER-SERVICE CARD

MULTIRANGE METERS



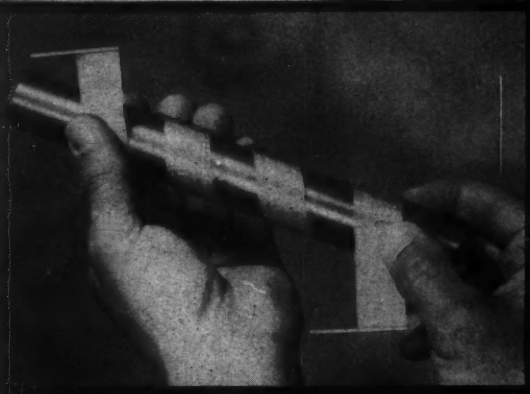
New line of Multi-Range Electrical Meters has fuses, full scale accuracy of ±2%. Model 410 is a triple-range a-c voltmeter (0-5, 25, 125 v), Model 420 a dual range a-c ammeter (0-2, 10 amp), Model 430 a triple range d-c voltmeter (0-5, 50, 500 v), Model 440 (illustrated) a triple range d-c ammeter (0-1, 1, 10), Model 450 a 7-purpose d-c galvanometer.—*Buck Engineering Co.*, 41 *Marcy St., Freehold, N. J.*

CIRCLE 305 ON READER-SERVICE CARD

CIRCLE 117 ON READER-SERVICE CARD ⟶

NEW WOVEN TEMPERATURE DETECTOR-GREATER ACCURACY AT LOWER PRICE!

Just peel off and stick on.



Form to fit curved surfaces.

Complete accuracy on irregular areas.

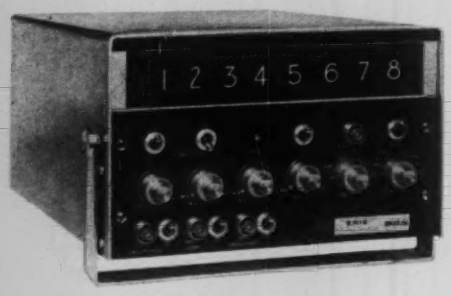
The new CIC Temperature Detector combines ruggedness and increased temperature ranges (up to 1000 degrees Fahrenheit) to give you a whole new parameter in the measurement of temperature by resistance change. Its unique design of nickel or platinum resistance wire woven through fiber glass carrying threads assures sharp and accurate response — higher resistance per linear inch — calibration within ½% — and complete freedom from strain gauge effect.

Best of all the price is one third to one half that of ordinary Temperature Detectors. **You have to see it to believe it!** Just drop us a line for complete information. Evaluation prototypes immediately available.

CONTROL INDICATING CORPORATION
AN AFFILIATE OF HI-G INC.
BRADLEY FIELD, WINDSOR LOCKS, CONN.

CIC

ERIE *Instrumation* MODEL 925
. . . the counter that remembers!!

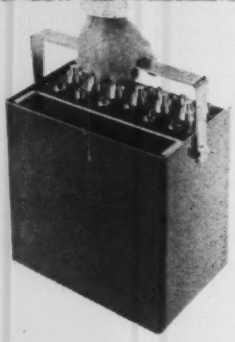


SOLID STATE
20 MC
UNIVERSAL COUNTER-TIMER

All new . . . the rugged, compact Model 925 is designed to offer the ultimate in reliable counting of periodic or random electrical events and precise measurement of Frequency, Period and Time Intervals. *Built-in memory* provides readout storage, continuous display while counting, more frequent sampling and less operator eye fatigue. Modular construction.

OUTSTANDING FEATURES:

- IN-LINE NIXIE READOUT
- 8 DIGIT MEMORY — No Blinking
- SENSITIVITY — .1V RMS — All 3 Channels
- THREE DC AMPLIFIERS
- HIGH INPUT IMPEDANCE
- AUTOMATIC DECIMAL POINT
- ONLY 3½" RACK SPACE (Model 925-R)
- DECADE TIME BASE — No Adjustments
- STABILITY — 1 Part In 10^8/Day; 5 Parts in 10^8/Week



ONE HAND PORTABILITY

Write today for complete specifications on the Model 925 or Model 925-R (Rack Model) — the ideal instrument for laboratory or industrial applications.

Quality Where It Counts

ERIE *Instrumation*

ERIE PACIFIC, DIVISION OF ERIE RESISTOR CORPORATION

12932 South Weber Way, Hawthorne, Calif. • ORegon 8-5418 • TWX HAW CAL 4006

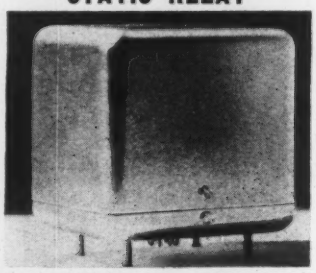
CIRCLE 118 ON READER-SERVICE CARD

WOVEN TEMPERATURE DETECTOR

New resistance Temperature Detector has platinum or nickel resistance wires interwoven with fiberglass threads to provide rugged, accurate, and inexpensive sensing element for use to 1,000°F. Detector is classified as ribbon-type; inherent design capability provides greater resistance per linear inch, ability to fit curved or irregular surfaces with almost complete absence of strain gage effects, excellent stability, reproducibility, accuracy, extreme sensitivity and speed of response, convenience, and interchangeability. Widths from ½" to 3", any length.—*Control Indicating Corp., Bradley Field, Windsor Locks, Conn.*

CIRCLE 306 ON READER-SERVICE CARD

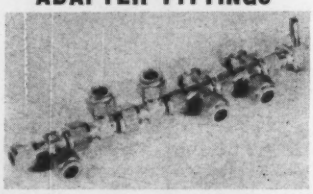
STATIC RELAY



New ultRelay, an ultra-sensitive, all solid-state device, responds to input power levels of 0.5 mw, handles up to 750 w/60 cps loads, and is virtually unaffected by shock and vibration. Provides power amplification ratios in the range of 90-100 db. Operates directly from thermocouple or other low-level transducer without intermediate amplification.—*Industrionic Div., Airborne Accessories Corp., 5456 W. Washington Blvd., Los Angeles 16, Calif.*

CIRCLE 307 ON READER-SERVICE CARD

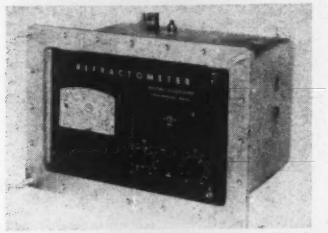
ADAPTER FITTINGS



New Swagelok Adapter Tees, Adapter Elbows, and Adapter Crosses afford connection into any standard Swagelok Tube Fitting without using itermediate lengths of tubing. Complex manifolds (illustrated) can be easily made, using these adapter fitings.—*Crawford Fitting Co., 884 East 140th St., Cleveland, 10, Ohio.*

CIRCLE 308 ON READER-SERVICE CARD

PROCESS REFRACTOMETER



New Process Differential Refractometer can measure full scale changes in refractive index as small as 0.00005 with a stability better than 1% of full scale in 24 hours. Sensitivity is 0.5% of full scale, or 0.00000025 R. I. Features include (1) the flowing reference cell which affords accurate blending of two streams even though one stream varies in composition, (2) possibility to measure PPM impurities in final product streams, due to its high sensitivity.—Details in Bulletin 4-1061.—*Waters Associates, 45 Franklin St., Framingham, Mass.*

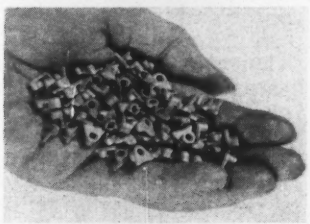
CIRCLE 309 ON READER-SERVICE CARD

MINI TAPE RECORDER

New miniature, continuous-loop Magnetic Tape Recorder, Model CL-90, can record and reproduce data from 1 to 14 channels under severe environmental and extremely limited space conditions. Speeds: 1.875, 3.75, 7.5 and 15 ips with up to 12-foot loop. Wow and flutter under static conditions is 1% rms or better.—*Aero Data Corp., Div. American Concertone, Inc., 9449 West Jefferson Blvd., Culver City, Calif.*

CIRCLE 310 ON READER-SERVICE CARD

SERVO MOUNTING CLAMPS



New Mounting Clamps for synchros, servomotors, pots, etc., are being offered in two sizes, each anodized in a different color.—*Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.*

CIRCLE 311 ON READER-SERVICE CARD

NEW

Atcotrol 305B Timer

NOW MORE VERSATILE THAN EVER

The new Atcotrol 305B incorporates the results of over 6 years of field experience in the control of timed industrial processes, laboratory and machine automation. Never before has an *automatic reset* timer been introduced with so much *proof* of reliability.

Check these NEW exclusive features

14 POINT TERMINAL BLOCK

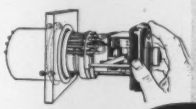
Internal and external electrical connections on terminal block where they belong . . . 14 terminals provide complete circuit flexibility.

● **ANTI BACK-UP DEVICE**

Unique gear train permits pointers to rotate in one direction only on short timing ranges.

BEZEL MOUNTING and LOCK

Provides flush mounting with recessed knob and dial. Timer setting may be Key-locked to prevent unauthorized tampering . . . optional feature.



QUICK DISCONNECT

Plug-in feature, optional, permits quick replacement of timer without disconnecting circuitry. Choose either type: plug-in or standard screw terminal installation.

MOST MODELS AVAILABLE FROM NATIONWIDE LOCAL STOCKS—WRITE FOR NEW BULLETIN 305B

atc

AUTOMATIC TIMING & CONTROLS, INC.

KING OF PRUSSIA, PA.

® A Subsidiary of American Manufacturing Company, Inc.

also new: ELAPSED TIME INDICATOR $10 with discounts to OEM's

Export Department: 1505 Race St., Philadelphia 3, Pa.
In Canada: Interprovincial Industries, 5485 Notre Dame St., West, Montreal 30, Quebec

CIRCLE 119 ON READER-SERVICE CARD

STOP

Standard Current Drifting in laboratory potentiometers

New DYNAGE BATT-SUB BS (TC)-2
is a reliable, constant DC voltage supply for lab potentiometer.

- ► *Replaces drift prone wet storage batteries and dry cells.*
- ► Typical applications:
  Leeds & Northrup
  Model K2 (3 v, 20.0 ma)
  Model K3 (3 v, 24.44 ma)
  Rubicon
  Models 2760, 2780, 2781, (3 v, 11.0 ma)
- ► Voltage stability: ±.001°%/ 10% input change input change
- ► Temp. stability: ±0.001%/°C over range of 15°C to 35°C

Low Priced . . . $95.00

Delivery: Stock to 3 weeks
(Specify voltage and current requirements when ordering)

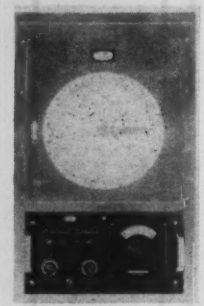
► Order your **BATT-SUB** today directly from **Dynage**, or write for complete specifications.

DYNAGE, INC.

390 CAPITOL AVENUE HARTFORD CONNECTICUT
Telephone CHapel 9-5654

CIRCLE 120 ON READER-SERVICE CARD

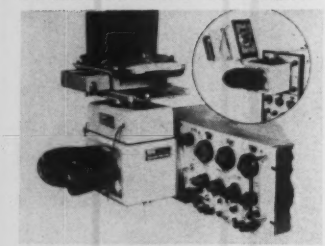
ELECTRONIC CONTROLLER



New Electronic Proportional Controller provides accurate, dependable, proportional off-on process control with almost imperceptible cycling. Measurable variables include temperature, pressure, pH, chemical concentration, liquid level, etc. Accuracy is ¼% of controller span as referred to accuracy of primary instrument.—*Thermo Electric Co., Inc., Saddle Brook, N. J.*

CIRCLE 312 ON READER-SERVICE CARD

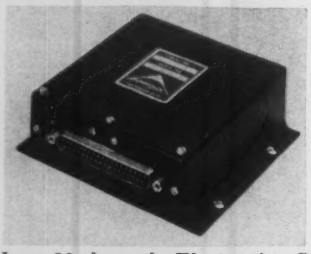
OSCILLOSCOPE CAMERAS



New Oscilloscope Cameras include low-cost Type 3005 with F/4.5 lens, for full-size Polaroid prints in 10 sec or less, with Type 47 roll film (3¼" x 4¼"); and four other camera systems which incorporate a 4" x 5" holder for Polaroid cut film. Types 3006 and 3007, have F/1.9 flat field and F/4.5 lenses, respectively; Types 3008 and 3009 systems are similar but include data chamber for identifying information on the film.—*Analab Instrument Corp., 30 Canfield Rd., Cedar Grove, N. J.*

CIRCLE 313 ON READER-SERVICE CARD

AIRBORNE COMMUTATOR



New 30-channel Electronic Commutator features low weight and volume (20 oz; 16 cu-in max), and output stability with levels maintained within ±0.5% of full scale. Specifications in bulletin.—*Electronics Div., Arnoux Corp., 1124 W. Washington Blvd., Los Angeles 66, Calif.*

CIRCLE 314 ON READER-SERVICE CARD

Dwyer CONTROLS GAGES

AIR VELOCITY METER No. 400

One Instrument Tells Both Air Velocity and Static Pressure!

- **Reads directly in feet per minute and inches of water.**
- **Check *all* velocities from 400 to 10,000 F.P.M.**
- **All static pressures from 0 to 10" of water.**

Tests fan and blower discharge and inlet pressures, pressure drop across filters, balances air conditioning systems, etc. Complete kit includes dual purpose manometer, 18" stainless steel pitot tube, Magneclip mounting panel and all necessary fittings, tubings, instructions and accessories.

Write today for literature and prices.

F. W. DWYER MFG. CO.
P. O. Box 373-S Michigan City, Ind.

CIRCLE 121 ON READER-SERVICE CARD

- a wide range of standard sizes
- colored tubing and special sizes
- a wide range of wall thicknesses
- prompt deliveries of

SPAGHETTI TUBING MADE FROM

TEFLON*

by Pennsylvania Fluorocarbon

To obtain outstanding results from sheathing for wires, slip-on insulation and bushings, use the unique electrical properties of spaghetti tubing made from Teflon plus the outstanding engineering and manufacturing techniques developed by Pennsylvania Fluorocarbon.

The unique electrical properties of spaghetti tubing made from Teflon include: good dielectric strength (1000-2000 volts/mil); lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric; no change of electrical properties with temperature (-25°C. to +250°C.), or frequency (60 cycles to 100 mc.); unaffected by moisture. In addition, PF Teflon is not harmed by the hot soldering iron so assembly work is speeded up considerably.

The outstanding engineering and manufacturing techniques developed by Pennsylvania Fluorocarbon include: the tailoring of Teflon with colors for identification or with modifications for improved texture and mechanical properties; stress relieving spaghetti tubing for minimum shrinkage; cleaning and 100% inspection; the manufacture of a wide range of wall thicknesses and special sizes.

Write, wire or call and let us quote on your requirements. We can provide overnight delivery of standard sizes and many special sizes at competitive prices.

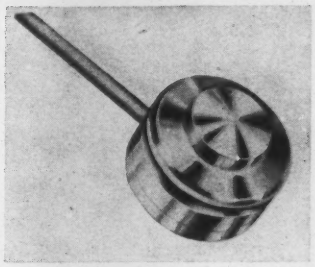
PENNSYLVANIA FLUOROCARBON CO., INC.

1115 N. 38th Street, Phila. 4, Pa.
EVergreen 6-0603 TWX: PH 252

*DuPont registered trademark

CIRCLE 122 ON READER-SERVICE CARD

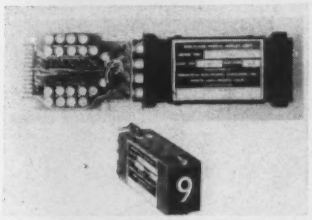
LOAD CELL



New Load Cell, Type BL-1, employs precisely-machined s.-s. bellows coupled inductively to ultra-sensitive differential transformer. Provides high continuous output with exceptional accuracy and repeatability. Diameter is 1¾", hysteresis error less than 0.1%. Available in ranges from 5 to 500 lb.—*United Aero Products Corp., Environmental Devices Div., Burlington, N. J.*

CIRCLE 315 ON READER-SERVICE CARD

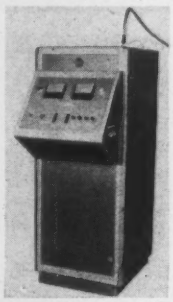
DECADE DISPLAY UNIT



New digital Decade Display unit comes complete with the lamp-driver printed-circuit-card attached. With two transistors per lamp, one for accepted binary coded decimal inputs and the other to amplify the signal to provide the correct power for driving, the complete package measures 2⅛" x 1¼" x 9½".—*Wang Laboratories, Inc., Natick, Mass.*

CIRCLE 316 ON READER-SERVICE CARD

D-C POWER SUPPLY



New high-voltage d-c Power Supply, Model 5492, rated at 100-kv, 10-ma output continuous duty has highly regulated output, automatic rate of voltage rise, and is short-circuit proof. Fast acting overvoltage and over-current breakers are incorporated, as well as neon, spark and electronic surge protectors. The high voltage connections are made through a plug-in shielded cable.—*Associated Research, Inc., 3777 Belmont Ave., Chicago 18, Ill.*

CIRCLE 317 ON READER-SERVICE CARD

STOP

- **Lost Batches in Process**
- **Data Reruns**

because of battery rundowns

New recorder voltage supply

replaces laboratory and industrial potentiometer standard and dry cells.

- *Stop excessive man hours for standardizing checks, battery replacements and mechanical repairs.*
- Can be used in potentiometers made by: Leeds & Northrup, Foxboro, Bristol, Minneapolis-Honeywell, and others.
- *Interchangeable between instruments because of external shunt resistor.*
- BATT-SUB is available in two models:
  BS-1 replaces dry cell only
  BS (TC)-1 replaces dry and standard cells.

Low Priced:

Model BS-1 .....$59.00
Model BS(TC)-1 .....$64.50
(Delivery stock to 3 weeks)
Write for specifications bulletin PS100-1 or order your BATT-SUB directly from Dynage.

DYNAGE, INC.

390 CAPITOL AVENUE HARTFORD CONNECTICUT

Telephone CHapel 9-3654

CIRCLE 123 ON READER-SERVICE CARD

Taber transducers probe rocket engine performance at Bell

The ruggedness, reliability and versatility of Taber Teledyne pressure transducers are amply demonstrated here. In this Bell Aerosystems' rocket engine test, six Taber bonded strain gage transducers are measuring chamber, hydraulic, valve actuation, tank, fuel and oxidizer pressures.

Three of the instruments (C, D, and F) have been in service at Bell for *more than 7 years!* The others are more current compact designs.

Taber transducers are available in a wide variety of models for test, ground support and airborne applications in pressure ranges from 0-50 to 0-10,000 psi. High frequency response, minimum hysteresis, infinite resolution and low sensitivity to temperature effects, vibration and shock are among their many plus features.

For illustrated literature, attach this coupon to your letterhead and mail.

TO: TABER INSTRUMENT CORPORATION
AEROSPACE ELECTRONICS DIVISION SECTION 243
107 Goundry Street, North Tonawanda, N. Y.

Send detailed information on Taber Teledyne and Teleflight bonded strain gage pressure transducers.

name _____ title _____

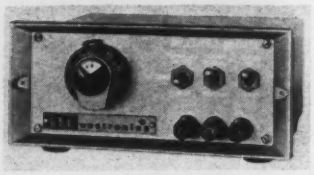
company _____ dept. _____

address _____

city _____ zone _____ state _____

CIRCLE 124 ON READER-SERVICE CARD

MILLIVOLT SOURCE



New EMV Electronic Millivolt Source is a secondary laboratory standard for calibration of instruments with high impedance input such as potentiometer recorders. A Zener-diode-regulated power supply provides a highly regulated voltage which is adjustable in two ranges from 0 to 100 mv. Accuracy is 0.1% of full scale output voltage. Noise output is less than 0.1 mv either across the output terminals or from either output terminal and ground.—*Westronics, Inc.*, 3605 *McCart, Fort Worth* 10, *Tex.*

CIRCLE 318 ON READER-SERVICE CARD

REFERENCE JUNCTION

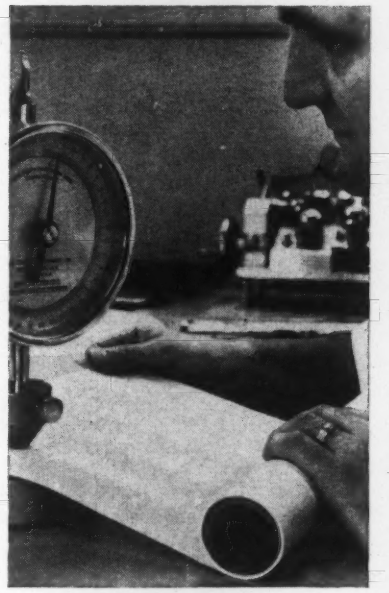
New Thermocouple Reference Junction, RJ-24, provides a constant reference temperature of 250°F with a 24 channel capacity. Uniformity between junction is 1°F. Ripple is less than ±1°F. Regulation throughout the environmental temperature range is less than 3°F. Nominal power consumption is less than 5 w.—*Astra Technical Instrument Corp.*, 12930 *Panama St., Los Angeles* 66, *Calif.*

CIRCLE 319 ON READER-SERVICE CARD

SENSITIVE RELAYS

New high-speed Switching Relays, utilizing a pair of magnetically operated contacts mounted in a glass tube hermetically sealed in a gaseous atmosphere, are capable of millisecond switching time, have an operating temperature range of −55°C to 150° C, and are relatively insensitive to shock and vibration. Carry loads from 15 voltamperes down to microamperes. Contacts are SPST or SPDT, normally open or biased closed, or a combination of both.—*Airpax Electronics Inc., Cambridge Div., Cambridge, Md.*

CIRCLE 320 ON READER-SERVICE CARD



A mil can matter

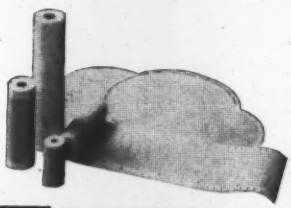
Even a *fraction* of a mil can bulk large in the thickness of a Recording Chart. That's why John Mazurowski and his thickness micrometer are so important to chart users.

Thickness of GC Recording Charts is painstakingly checked to make sure the charts you buy from us will give you the *right* answer *all* the time.

Take rigid inspection standards like these and add repeated paper and ink tests, continuous humidity control in production and storage areas, and speed of printing and delivery—you'll see why more than 5,000 chart users rely regularly on GC for quality and dependability.

More than 15,000 different chart types are stocked at GC. We also design and print charts for any special purpose you may have.

Let us send you our new complete stock list.



RECORDING CHARTS

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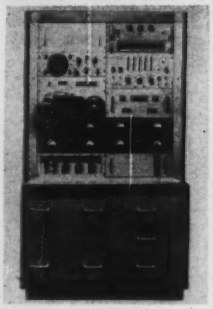
CIRCLE 125 ON READER-SERVICE CARD

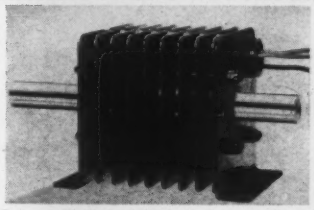
ELECTRONIC SYSTEM TESTER



New Adept 400 Test Equipment, a tape-programmed unit for maintenance analysis and calibration of complete electronic systems and components, permits automatic test by punch paper commands on both static or dynamic basis. Test results are recorded on paper tape.—*Ortronix, Inc., Drawer* 8217, *Orlando, Fla.*

CIRCLE 321 ON READER-SERVICE CARD

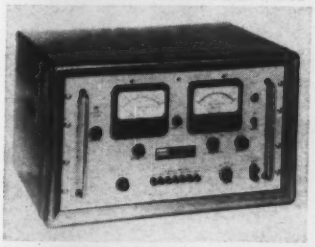
LINEAR VALVE ACTUATOR



New Polynoid electromechanical linear actuator, utilizing induction principles to deliver a uniform long stroke, contains only one moving part, the rod, and can be used to hold under load at any position or provide reciprocating motion. Actuator produces uniform output force throughout its stroke in either direction, directly proportional to input power.—*Skinner Precision Industries, Inc., New Britain, Conn.*

CIRCLE 322 ON READER-SERVICE CARD

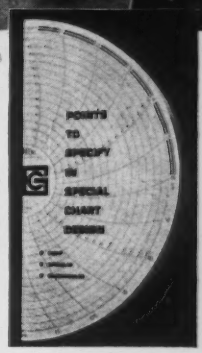
DEVIATION CALIBRATOR



New FM-monitor Deviation Calibrator, Monocal 500, combines functions of FM signal generator, low-distortion audio oscillator, audio frequency counter, selective receiver, and carrier-dropout visual indicator. Can be used directly with any FM monitor tuning to 12 Mc or equipped with a 12 Mc IF strip. Also serves as an FM signal generator with high deviation precision, when combined with appropriate mixers and local oscillators.—*Advanced Measurement Instruments, Inc.,* 109 *Dover St., Somerville* 44, *Mass.*

CIRCLE 323 ON READER-SERVICE CARD

GC Recording Charts are accurate



New booklet helps solve SPECIAL CHART problems

If you have a unique recording or control problem which a stock chart won't fit, GC's experience will work for you.

This free booklet, "Points to Specify in Special Chart Design," offers many useful tips to consider before specifying or designing a special chart. It suggests possible types of paper, sizing of punched holes, ink colors, overprinting, grid line widths, etc.

GC service—and this booklet—can eliminate false starts and wasted time. Let us serve you. Just send this coupon.

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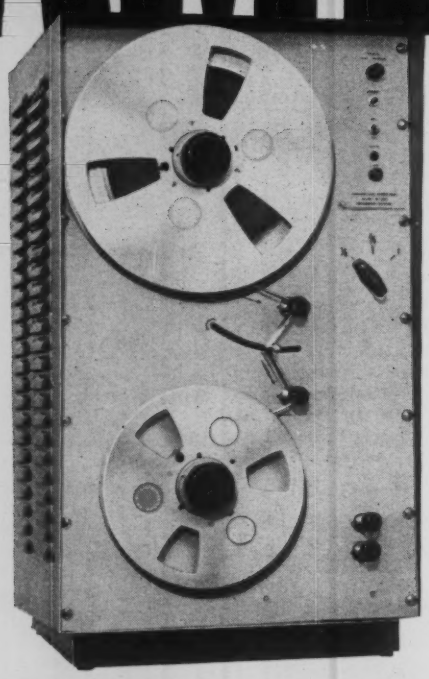
Buffalo 10, New York

Please send me your new folder "Points to Specify in Special Chart Design." No charge or obligation, of course.

Name_____
Firm_____
Address_____
City_____ State_____

CIRCLE 126 ON READER-SERVICE CARD

TAPE TAMER



NEW EECO HIGH-SPEED MAG TAPE REWIND UNIT $690, 6 WEEKS DELIVERY

Tame your tape rewind problems at the industry's lowest cost for all these features. Fast automatic stop when tape ends or power fails. Rewinds 10½" reel in 75 seconds. Constant tension for unusually even winding. Tension selector. Universal hub accepts NAB, UNIVAC or IBM reels. Precision guides handle ½", ¾" or 1" tape without adapters. Unit takes reels up to 14" diameter. Operates on 115v ac, 60 cps, 150 va. Initial availability 6 weeks. Send for Data File TR-300.

AUTOMATION DIVISION

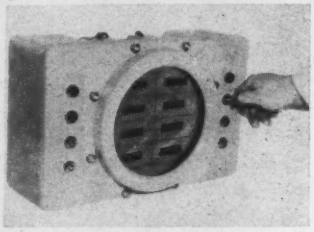
Electronic Engineering Company *of California*

EE 1-32

1601 E. Chestnut Ave. • Santa Ana, Calif. • KImberly 7-5501 • TWX: S ANA 5263

CIRCLE 127 ON READER-SERVICE CARD

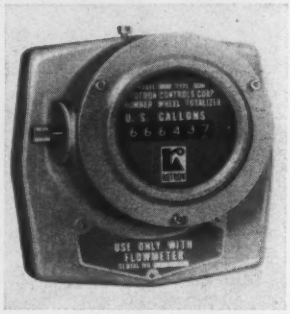
BULK MEASUREMENT CONTROL



New automated Measurement Control Systems for reading fluids at bulk storage terminals is electrically-operated by key control. System consists of (1) an explosion-proof impulse contactor, (2) a completely enclosed, explosion-proof key control panel, and (3) a registered key for each external lock.—*Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.*

CIRCLE 324 ON READER-SERVICE CARD

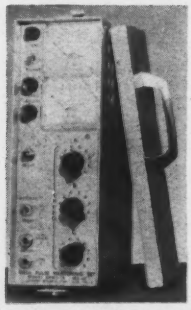
NUMBERWHEEL TOTALIZER



New odometer-type Numberwheel Totalizer is used with Rotron Whirl-Flo flowmeters which employ the vortex-velocity principle. Model GP-R has zero reset, Model GP has none. Totalizer consists of a magnetic input coupling, a gear train, and a mechanical register.—*Rotron Controls Corp., Woodstock, N. Y.*

CIRCLE 325 ON READER-SERVICE CARD

DATA PULSE MEASUREMENT

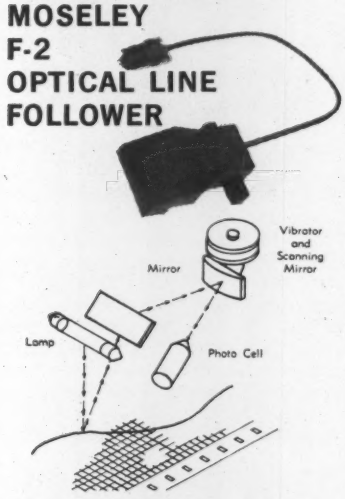


New high-speed Data Pulse Measuring Set, Model DPMS-1, that measures time distortion in DataPhone signals can be arranged for any of 999 different speeds from 362 through 2,625 bits/sec. Indicates peak distortion monitored, or follows changes in the steady-state level of distortion. —*Altantic Research Corp., Alexandria, Va.*

CIRCLE 326 ON READER-SERVICE CARD

PLOT YOUR PROGRAM

TRACK IT WITH A MOSELEY F-2 OPTICAL LINE FOLLOWER



Through regeneration of previously recorded electrical data, the Moseley F-2 Line Follower can be used for graphic data analysis, process or machine program control, function generating and other lab and industrial applications.

The F-2 optically follows any black line, including pencil traces, tracks curve slopes up to 80° at paper speeds up to 15 in./min., includes built-in relays for external circuit control. It is available, factory installed on an 80A or 2D Recorder, for $750.00.

Extremely flexible in operation, programs are prepared quickly and can be changed easily—simply by drawing another line. The F-2 offers large programming capacity, with use of roll charts up to 120 feet in length. Permanent records are made immediately, may be stored indefinitely.

The Autograf 2D Recorder and F-2 Line Follower are combined in the Moseley 2D-5 Transport Delay Simulator, which records in analog form a function representing a process control or experimental operation and then reproduces that process after a selected delay time. Readout delay is adjustable from 4 seconds to 7 minutes.

Moseley Application Note AN 102 discusses "Program Controllers", including use of the F-2 with Model 80A and Model 2D-5.

Write or call today for the application note and for complete specifications on the Line Followers, compatible Autograf Recorders and the Transport Delay Simulator.

AUTOGRAF *recorders*

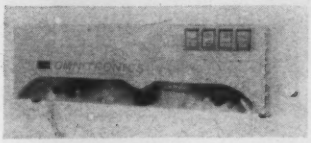
F.L. MOSELEY CO.

Dept. J-7, 409 N. Fair Oaks Ave., Pasadena, Calif.
MUrray 1-0208; Area Code 213
TWX PASA CAL 7687, Cable MOCOPAS

Field representatives in all principal areas. Data subject to change without notice. Prices f.o.b. Pasadena. Pioneer and leader in X-Y and Strip Chart Recorders. 7297

CIRCLE 128 ON READER-SERVICE CARD

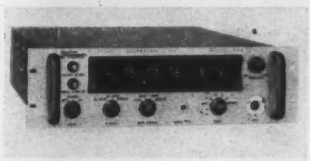
BIDIRECTIONAL TAPE READER



New bidirectional Photoelectric Tape Reader, Model PTR-71, features instantaneous tape reversal by use of a unidirectional synchronous speed motor. An increased signal-to-noise ratio is achieved through the application of reflected chopped light in the actual reading process. Reads all standard tape widths and up to eight channels plus sprocket in either strip, loop, or reel tape modes at any one of nine standard speeds up to 100 ips. Bulletin PTR-71 available.—*Omnitronics, Inc., Borg-Warner Subs., 511 North Broad St., Phila. 23, Pa.*

CIRCLE 327 ON READER-SERVICE CARD

DIGITAL VOLTMETER



New 5-digit Voltmeter with solid-state circuitry has no moving parts or contacts. Speed is 20 readings/sec with absolute accuracy of 0.01%. Range is ±0.0001 to ±999.99 vdc.—*Electro Instruments Inc., 8611 Balboa Ave., San Diego 11, Calif.*

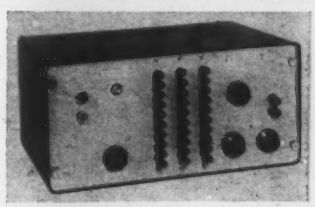
CIRCLE 328 ON READER-SERVICE CARD

SLUDGE FLOWMETERING

New Flowmetering System comprises an electromagnetic-induction obstructionless flow primary element mounted in the sludge line and a transistorized recorder. Automatically-controlled heating prevents grease build-up within the tube but does not lead to carbonizing at the electrodes. Accuracy is better than ±1%. Transistorized receiving recorder has full scale response of less than 5 sec.—*Fischer & Porter Co., Warminster, Pa.*

CIRCLE 329 ON READER-SERVICE CARD

LOW DISTORTION OSCILLATOR



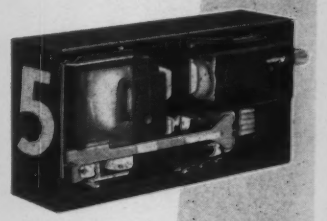
New Model 446 1 cps to 100 kc stable-amplitude Oscillator features 0.01% amplitude stability and only 0.01% distortion. Frequency calibration accuracy is within 1% from 1 cps to 10 kc.—*Krohn-Hite Corp., 580 Massachusetts Ave., Cambridge 39, Mass.*

CIRCLE 330 ON READER-SERVICE CARD

BINARY OPERATED READOUT

New! *Operates Direct—No Buffers or Translators Required*

ALL DIGITS CAN BE READ FROM ANY ANGLE



BINA-VIEW Self-Decoding Alpha-Numeric Readout

Applications: Connected directly into computers, teletype, etc.

Features: Electro-magnetic operation, low power (10 milliwatts), accepts BCD code to 6 bits, does own translating.

Specifications: 1⅜" high character, module size 1¾" x 3¼" x 6¾"

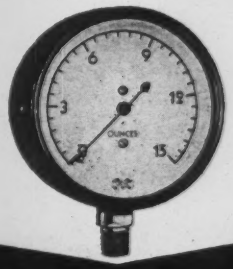
Price Complete from $50.00

WRITE TODAY FOR COMPLETE DETAILED INFORMATION

INDUSTRIAL ELECTRONIC ENGINEERS, Inc.

5528 VINELAND AVENUE
NORTH HOLLYWOOD, CALIF.
Representatives in principal cities.

CIRCLE 129 ON READER-SERVICE CARD



MARSHALLTOWN

DIAPHRAGM GAUGES

for accurate pressure measurement in ounces or inches of water

Standard dials reading in inches of water, ounces, centimeters or millimeters up to 10 P.S.I. All Marshalltown diaphragm gauges are extremely sensitive and accurately measures very low pressures.

Let Marshalltown answer your gauge problems . . . write for information and prices.

MARSHALLTOWN MANUFACTURING, INC.
A Subsidiary of The Electric Autolite Company
MARSHALLTOWN, IOWA

CIRCLE 130 ON READER-SERVICE CARD

LUDLOW
SPECIALLY-DESIGNED CUSTOM PAPERS for your special RECORDING INSTRUMENT

Sophisticated instruments that chart critical variables demand sophisticated recording papers. That's why more and more recording instrument manufacturers are turning to Ludlow, patent holders of the first non-wax thermal and pressure sensitive chart papers.

Ludlow research and engineering design will go to work for you to create to your precise specifications the exacting, ultra-sensitive recording papers required to produce ultimate performance from a fine instrument . . . records free of failures or inaccuracies. Write Dept. CE-41 for literature and samples. Include your requirements or special problems.

LUDLOW PAPERS
WARE, MASSACHUSETTS
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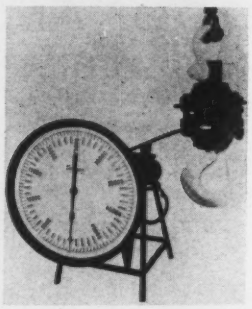
Ludlow

CUSTOM
CHART PAPERS

CIRCLE 131 ON READER-SERVICE CARD

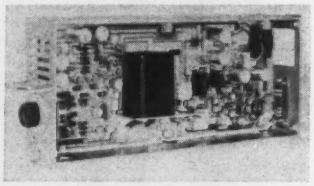
CRANE SCALES



New Sensater Remote Indicating Crane Scales with capacity ranges from 500 to 60,000 lb feature minimum headroom loss which allows greater stacking space in storage areas. Calibrated in uniform increments. Bulletin M-25H.—*Martin-Decker Corp.*, 3431 *Cherry Ave., Long Beach 7, Calif.*

CIRCLE 331 ON READER-SERVICE CARD

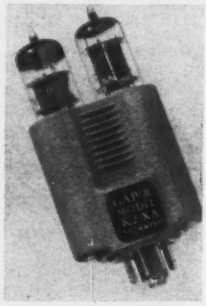
DIFF DC AMPLIFIER



New solid-state Differential DC Amplifier, Type 101A, features input, output, and chassis isolated from each other. Output of ±10v at ±10 ma drives a capacitive load of up to 5 mfd. Common mode rejection is 100,000,000:1 at dc; 1,000,000:1 at 60 cps.—*Neff Instrument Corp.*, 1088 *East Hamilton Rd., Duarte, Calif.*

CIRCLE 332 ON READER-SERVICE CARD

OPERATIONAL AMPLIFIER



New K2-XA, an octal plug-in Operational Amplifier features a d-c open-loop gain of 30,000 (typical average), low drift, differential input, and high input (open grid) impedance. When operated as a unity gain amplifier, it has a band pass of 250 kc, and an output impedance at low frequency of 0.2 ohm. It will deliver up to 3 ma at ±100v.—*George A. Philbrick Researches Inc.*, 127 *Clarendon St., Boston 16, Mass.*

CIRCLE 333 ON READER-SERVICE CARD

NOW YOU CAN BUY

OFF THE SHELF! FOR IMMEDIATE SHIPMENT*

transmitters (1HG, 1HG400, 5HG, 5HG400)
. . . angle transmission units for torque transmission and servo control systems.

receivers (1F, 1F400, 5F, 5F400)
. . . used as receivers in torque transmission systems. Have shaft damping to prevent oscillation and overcome any tendency to spin.

control transformers (1HCT)
. . . produce an a-c voltage at the rotor terminals that depends on rotor shaft position and the voltages applied to windings.

differential transmitters (1HDG, 5HDG)
. . . "add in" other shaft positions when connected between transmitter and receiver or control transformer.

Use Telesyn synchros for extremely accurate drives and indicators of position, pressure, flow or other synchro-transmitted information.

A pioneer in the field of synchronous transmissions, Ford Instrument Company produces synchros of proven precision.

- Available to meet MIL specs.
- In sizes to meet a multiple of requirements.
- For torque transmission and voltage indication.

**Subject to prior sale. Ford inspection 7 days A.R.O.—Government inspection 12 days A.R.O.*

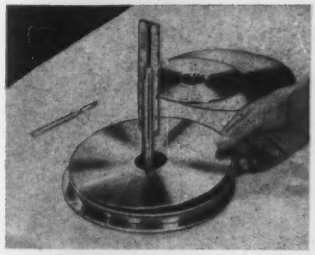
1.3

FORD INSTRUMENT COMPANY

Division of The Sperry Rand Corporation
31-10 Thomson Ave., Long Island City 1, N. Y.

CIRCLE 132 ON READER-SERVICE CARD

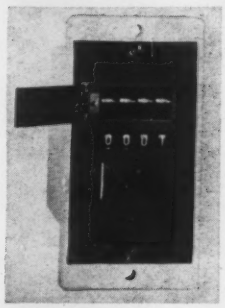
FOAM TESTER



New portable Wohler Foam Tester is for urethane foam testing as specified by SPI, RMA, and ASTM. Based on simple dead weight principle. Bulletin gives details.—*Browning Instrument Co., Box 152, Bath, Ohio.*

CIRCLE 334 ON READER-SERVICE CARD

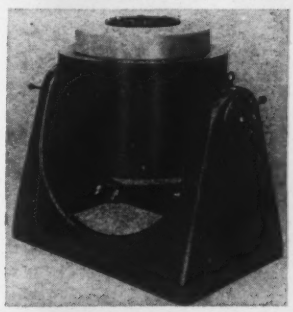
PREDETERMINING COUNTER



New 4-digit Sodeco predetermining electric-impulse Counter, Type 2TCeF4PE, provides a visual in-line count, and a control function. Available with either push button manual or remote electric instantaneous reset. Built-in rectifier permits direct operation from a 110 or 220-vac source. Rated speed is 1500 counts/min.—*Landis & Gyr, Inc., 45 West 45th St., New York 36, N. Y.*

CIRCLE 335 ON READER-SERVICE CARD

ELECTRODYNAMIC SHAKER



New electrodynamic Shaker, Model 300, with 5,000-lb force rating and built-in "piggy-back" capability for environmental testing, features closed-loop cooling system for field and armature structures. Maximum load for 10-g vector is 450 lb, for 20-g vector 200 lb. Maximum acceleration is 100 g's. Frequency range is 5 to 3,000 cps.—*Ling Electronics Div. Ling-Temco Electronics, Inc., 1515 S. Manchester, Anaheim, Calif.*

CIRCLE 336 ON READER-SERVICE CARD

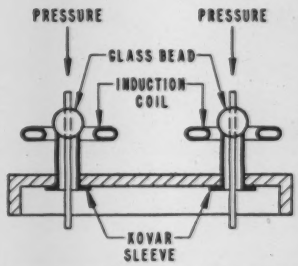
LepeL

HIGH FREQUENCY *Induction* HEATING UNITS

Lepel induction heating equipment is the most practical and efficient source of heat developed for numerous industrial applications

Typical Induction Heating Applications

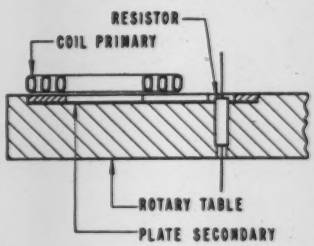
Glass to Metal Seals



Induction heating is ideal for the assembly of glass beads to pre-oxidized Kovar metal sleeves for a header sub-assembly. The glass-Kovar joint area is brought to 1550° F while pressure is applied to the glass beads.

Our engineers will process your work samples and return the completed job with full data and recommendations without cost or obligation.

Production Soldering Resistors With Long Pigtails



Heating occurs in small opening of plate secondary which is electromagnetically coupled to stationary primary. This produces highly localized heating while avoiding intereference of pigtail with the coil. One turntable contains a number of loading positions.

WRITE FOR NEW LEPEL CATALOG

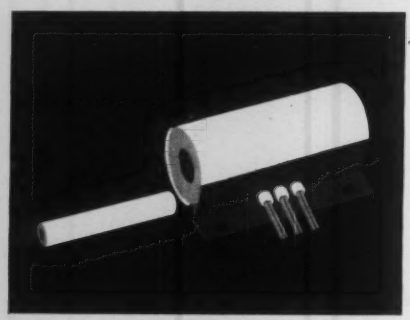
LepeL HIGH FREQUENCY LABORATORIES, INC.
55th ST. & 37th AVE., WOODSIDE 77, N. Y.
CHICAGO OFFICE: 6246 WEST NORTH AVE.

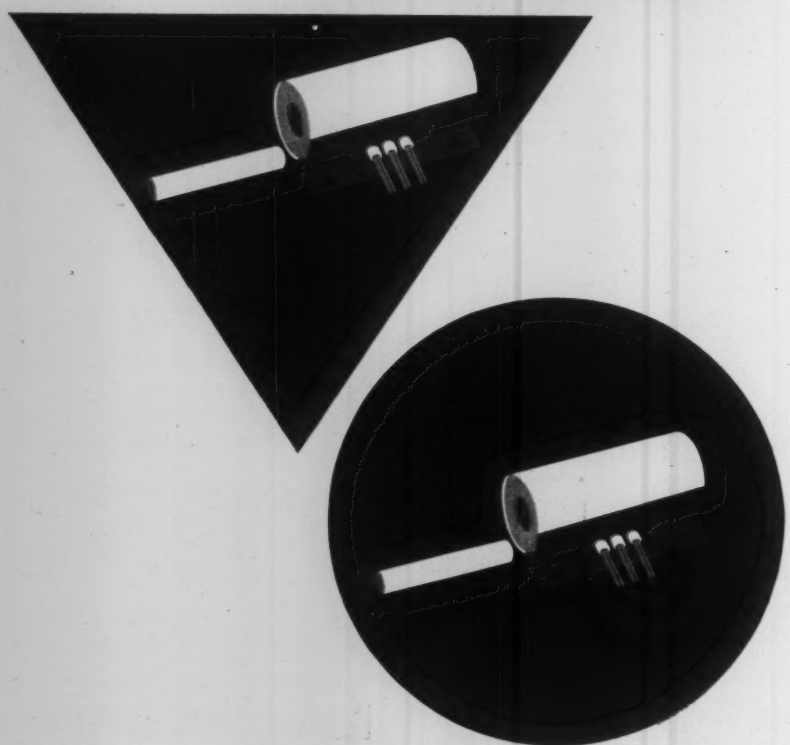
CIRCLE 133 ON READER-SERVICE CARD

UNIVERSAL DIFFERENTIAL TRANSFORMERS Truly universal. Six types do same job as hundred conventional models. Easy as pie to choose right transducer. Standardization cuts production costs. Clean room manufacture builds more accurate, more reliable transducer. Even at lower price! Complete details Bulletin 400. Write, call, run.

DM **DYNAMIC MEASUREMENTS COMPANY**

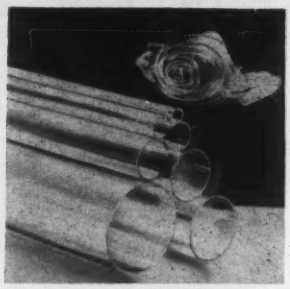
TERWOOD ROAD, WILLOW GROVE, PA. OLdfield 9-9110





CIRCLE 134 ON READER-SERVICE CARD

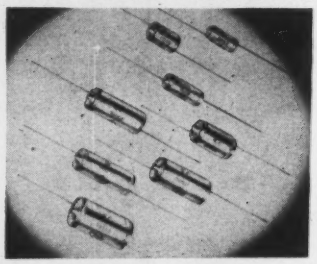
TRANSPARENT BUTYRATE



New Busada "200" transparent butyrate Plastic Tubing is now being offered in 76 standard sizes ranging from 0.750" OD with a $\frac{1}{16}$" wall thickness up to a 6.625" OD with a $\frac{1}{4}$" wall thickness.—*Busada Mfg. Corp., 32-21 Downing St., Flushing 54, N. Y.*

CIRCLE 337 ON READER-SERVICE CARD

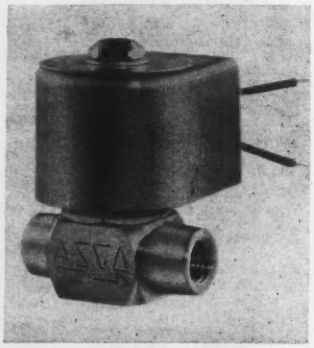
POLYSTYRENE CAPACITORS



New line of sealed Polystyrene Capacitors with leakage resistance in excess of 500,000 megs/mfd includes 125 DCVW and 500 DCVW units with capacities from 20 mmf to 0.025 mfd, and 25 VDCW units, from 5000 mmf to 0.1 mfd. Tolerances are 2.5%, 5.0%, 10% or 20%. Details in Bulletin EP-1034R.—*Electronics Div. Globe-Union Inc., 900 East Keefe Ave., Milwaukee 1, Wis.*

CIRCLE 338 ON READER-SERVICE CARD

SOLENOID VALVE



New midget packless-type 2-way Solenoid Valve, for handling cryogenic liquids and gases from 100°F to temperatures approaching absolute zero, is supplied in either brass or stainless steel with Teflon discs and gaskets. Can be mounted in any position. Form V5126 gives details.—*Automatic Switch Co., Florham Park, N. J.*

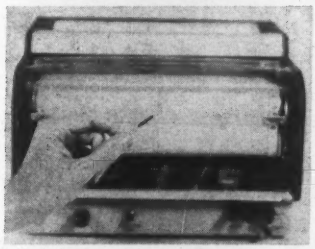
CIRCLE 339 ON READER-SERVICE CARD

STRAIN GAGES

New line of Weldable Strain Gages, providing electrical stability from cryogenic temperatures through 750°, is for pressure testing through 750°, reactor power loops, liquefied-gas pressure vessels and systems, aircraft and missile components and engines, etc. Made in two basic types: (1) phenolic-bonded Constantan foil for temperatures to 500°F and (2) ceramic-bonded Nichrome V foil, for temperatures to 750°F continuous, or 1000° short-term. Operate in a strain range of ±½% (±5000 μin/in).—*Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., Waltham 54, Mass.*

CIRCLE 340 ON READER-SERVICE CARD

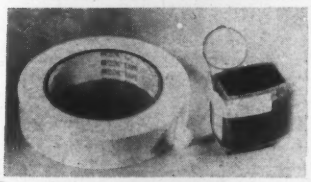
LO-TEMP MEASURING SYSTEMS



New low-temperature Cryogenic Measuring Systems include a germanium thermometer (cryometer) and a special "servo/riter" potentiometric recorder. One system consists of a model PWSB "servo/riter" recorder multi-range resistance bridge and the Model 341 germanium thermometer probe. Resistance readings from 9-1,110,000 ohms in five decades obtained are easily convertible to degrees Kelvin (approximately 40° —1°). The second system, including Model FWSK 1 "servo/riter" liquid hydrogen recorder and Model 342 germanium thermometer probe, gives direct readings of the hydrogen range in degrees Kelvin (18° —28°).—*Texas Instruments, Inc., Box 6027, Houston 6, Texas.*

CIRCLE 341 ON READER-SERVICE CARD

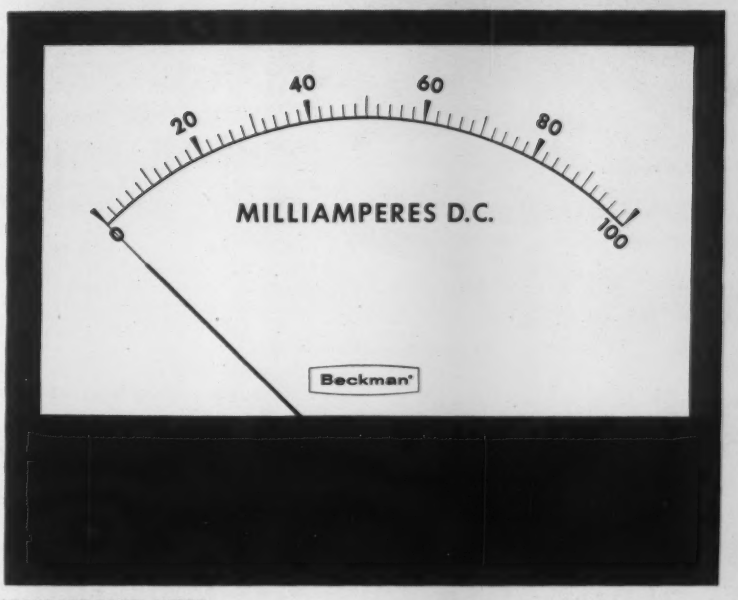
THERMOSETTING TAPE



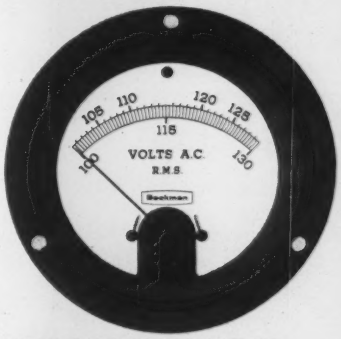
New thermosetting glass-cloth Tape, Brand No. 7020, cures in only one-half hour at 350°F. Designed for Class "B" operating temperatures.—*Mystik Adhesive Products, Inc., 2635 No. Kildare Ave., Chicago 39, Ill.*

CIRCLE 342 ON READER-SERVICE CARD

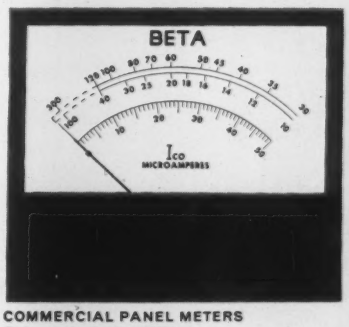
NOW...THE RIGHT ANSWER TO YOUR METER PROBLEM HAS A CLEAN NEW LOOK!



STANDARD PANEL METER
4" x 6" size, 0-100 Milliamps



EXPANDED SCALE AC VOLTMETER
3½" Ruggedized and Sealed



COMMERCIAL PANEL METERS
Beta ray indicator—4½"

Here's the clean, uncluttered look in meters—handsome appearance, sensible proportions. These meters are precision-built by Helipot—every one ruggedly constructed for lasting accuracy. All-metal frames, gasket sealed, steel movement enclosures, glass windows.

Whatever your meter problem, you'll find the right answer at Helipot; nearly 600 standard models that can be readily customized for your application. For routine metering jobs or for the most unique ranges and purposes—custom scale plates, special expansions, special calibration accuracies, multiple range meters. You name it.

You get faster service at Helipot. Standard models are shipped in 30 days, specials in only 45 days.

And you get better, more convenient service. At Helipot, the smallest order receives the same consideration as the largest. And the entire job can be handled through your nearest Helipot Sales Engineering Representative. Call him or write directly to Helipot for more details. Your meter problems are as good as solved!

Beckman INSTRUMENTS, INC.
HELIPOT DIVISION
Fullerton, California
POTS : MOTORS : METERS

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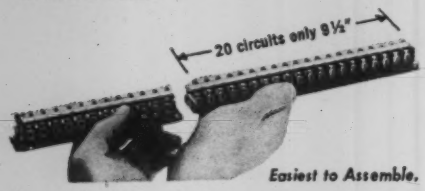
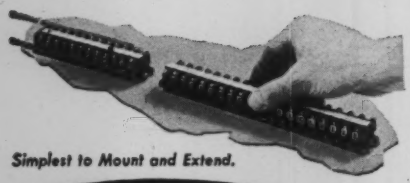
CIRCLE 135 ON READER-SERVICE CARD

MD pres-SURE-blocks—DESIGNED for QUICK Assembly and EASY Changes

Quickest to Handle.



Easiest to Assemble.



Simplest to Mount and Extend.

ANY NUMBER OF CIRCUITS — pre-assembled lengths of 20 snap fit circuits (1-1/8" w. x 63/64" h.). No single pieces to handle, pull off or add circuit groups as needed. Single snap-on end section completes block.

HAND ASSEMBLED without hardware; only 2 parts to handle; use mounting screws only every 12 circuits. Channel mounting also available; integral or separable marking strips.

LARGER CAPACITY IN LESS SPACE—#22 thru #8; conservative 750 volt A.I.E.E. rating ... Choice of contacts (7/16" o.c.) for stripped or terminal-ended wires (can be combined in single block).

LENGTHEN IN SERVICE without removing mounting screws or losing contact space.

USE FEWER CIRCUITS by grouping common wires—decrease jumpering; no unused contacts.

Tubular contacts listed by UL. Blocks listed for 600 volts by CSA. U. S. Pat. No. 2,922,139

Write for Bulletin IC-7

BUCHANAN

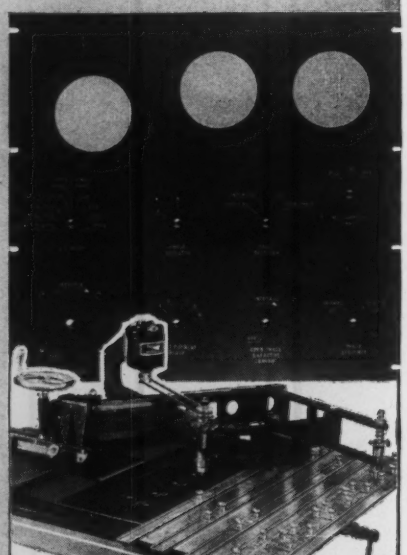
BUCHANAN ELECTRICAL PRODUCTS CORPORATION
HILLSIDE, NEW JERSEY
In Canada: ESNA CANADA LIMITED, Toronto 16

BOOTH 421—WESCON SHOW—SAN FRANCISCO

CIRCLE 136 ON READER-SERVICE CARD

any size panels

engraved in your own plant



Engrave 1-inch nameplates or 6-foot panels by unskilled labor.

Spindle covers 18¼" x 6" in one set-up — more than any other machine of its kind.

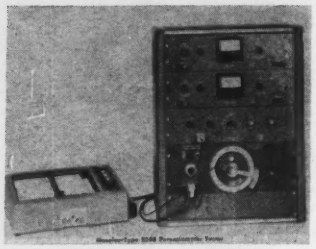
Bench type model I-R—$685.

Send for complete catalog JR-4 illustrating other models from $325 up

neir hermes ENGRAVING MACHINE CORP.
154 WEST 14th STREET, NEW YORK 11, N. Y. IN CANADA: 359 St. James Street West, Montreal, P. Q.

CIRCLE 137 ON READER-SERVICE CARD

POTENTIOMETER TESTER



New Potentiometer Tester, Type 2398, supplies X and Y d-c signal voltages representing shaft rotation and resistance, respectively to any Autograf X-Y recorder. Operates in two-switch-selected ranges 1 ohm to 1 Mohm and 10 ohms to 10 Mohms and provides 120-db resistance measurement capability. Accuracy of the Log R portion of the system is ±0.4% of full scale; angular rotation is accurate to ±0.2% of full scale.—*F. L. Mosely Co., 409 North Fair Oaks Ave., Pasadena, Calif.*

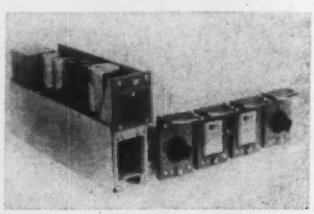
CIRCLE 343 ON READER-SERVICE CARD

VHF-UHF POWER OSCILLATORS

New line of Power Oscillators, Models 408 and 410, for antenna evaluation, calibration of power measuring devices, driving amplifiers, etc., is continuously tunable over 2 to 1 frequency bands, and has a high ratio dial featuring zero backlash and a logging scale permitting a resettability of 0.002%. Range, Model 408: 50 mv to 25 w, Model 410: 50 mv to 50 w. Stability: ±0.2 db/hour ±1 db.—*Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.*

CIRCLE 344 ON READER-SERVICE CARD

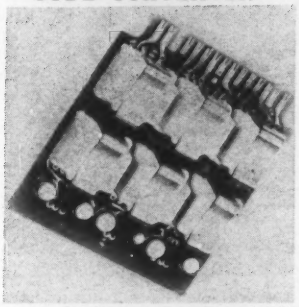
ATTENUATORS



New Plug-In Attenuator units for the 112A wideband d-c amplifier include (1) Type 112A/A (phase inverting), which provides 11 gain steps from 0 to 1000 with continuous 1 to 2 times variation of each step by potentiometer. Gain accuracy is ±0.5% dc to 2 kc. Gain stability is 0.1%. (2) Type 112A-B plus-one (non-inverting) providing gain of +1, gain accuracy @dc of ±0.001%; @2kc, ±0.1%. Gain stability is ±0.001% @dc, ±0.1% @ kc. (3) Type 112A-AO, identical to type 112-A plug-in except having an operational switch position, and (4) Type 112A-O, an empty plug-in with circuit boards for installing resistances.—*Kin Tel Div. Cohu Electronics, Inc., Box 623, San Diego, Calif.*

CIRCLE 345 ON READER-SERVICE CARD

CODE CONVERTER



New Code Converter, Type CC-501, consists of six transistor-driven printed circuits relays mounted on a single module primarily for binary-coded decimal-to-decimal conversion. The BCD inputs are four d-c voltages from decade counters, shift registers, or similar modules. Output at which the signal appears is determined by the BCD inputs. Decimal input may be high voltage or high current, ac or dc, positive or negative, determined by the device to be operated by the outputs.—*Control Equipment Corp., 19 Kearny Rd., Needham Heights 94, Mass.*

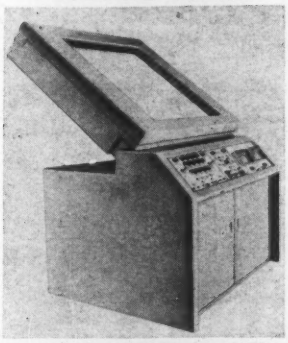
CIRCLE 346 ON READER-SERVICE CARD

FORCE TRANSDUCERS

New Force Measuring Transducers (load cells) employ a basic ring configuration, with high-temperature weldable strain gages (resistance-wire-type) in a bridge configuration as sensing elements. Load Range (full scale): 100 to 500,000 lb. Total error from all causes is less than ±1% over the temperature range of −300°F to +750°F.—*Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.*

CIRCLE 347 ON READER-SERVICE CARD

PLOTTING BOARD



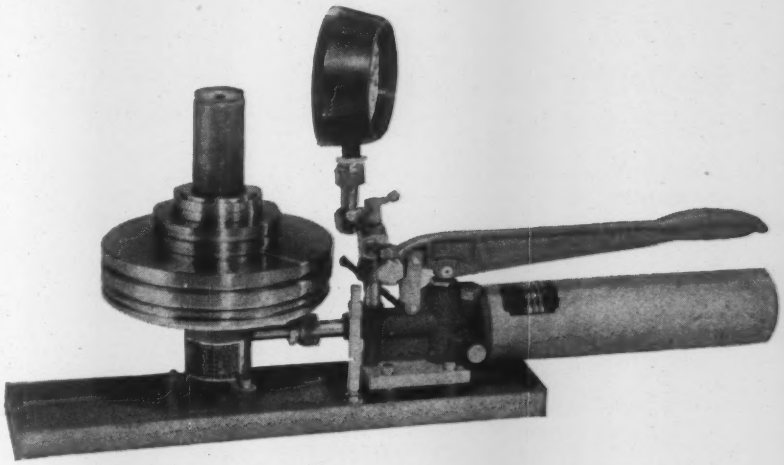
New Model 1587 Vertical/Horizontal Plotting Board operates with analog and digital computers, coordinate converters, radars, and other analog devices. Has electrical tilting of plotting surface. Plots via recording pens mounted on separate movable arms, capable of traversing the entire 30" x 30" plotting surface, with acceleration of the pen at 1350"/sec² and arm at 450"/sec².—*Milgo Electronic Corp., 7620 N. W. 36th Ave., Miami 47, Fla.*

CIRCLE 348 ON READER-SERVICE CARD

PRESSURE TESTERS

TYPE T
DISTILLED WATER SERVICE
TYPE R
OIL SERVICE

WORKING PRESSURES TO 13,000 PSI



FOUR testers in ONE unit

1. Portable pressure testing.
2. Comparator testing with test gages.
3. Dead weight testing.
4. Dead weight gage.

PLEASE REQUEST CATALOG 761

MANSFIELD & GREEN INC.
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CIRCLE 138 ON READER-SERVICE CARD

FIRST AND ONLY
RECORDING pH METER

Permanent pH Record • Simple to Operate • Adaptable • No Ink

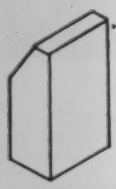
A pH meter and strip chart recorder in one. Line operated. Continuously indicating. Can record continuously for 31 days at one inch per hour. 0-14pH. With manual temperature compensator. Write for Bulletin No. 3R.

Price $245.00 complete, with Analytical protected pH probe unit

ANALYTICAL MEASUREMENTS, INC.
585 Main Street
Chatham, New Jersey

CIRCLE 139 ON READER-SERVICE CARD

DIGITAL FINAL CONTROL ELEMENTS FOR AUTOMATION

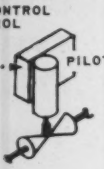


SET-POINT CONTROL SIGNAL
- BINARY/OR
- BINARY-DEC-CODED/OR
- CYCLIC/OR
- TERNARY

- DIGITAL COMPUTER/OR
- PUNCHED TAPE PROGRAMMER/OR
- SPECIAL PURPOSE DIGITAL CONTROLLER/OR
- DIGITAL SHAFT ENCODER/OR
- REMOTE MANUAL CONTROL STA./OR
- OTHER MEANS

- BINARY/OR
- BINARY-DEC. CODED

DIGITAL CONTROL VALVES
- PRECISION FLOW CONTROL
- BLENDING FLOW CONTROL
- EXTREMELY LOW FLOW CONTROL
- PROCESS CONTROL
- FUEL CONTROL



PILOT
- BINARY/OR
- BINARY-DEC./OR
- CYCLIC/OR
- TERNARY

PILOT OPERATED DIGITAL POSITIONERS
- LARGE CONTROL VALVES
- BIN GATES
- HOPPER GATES
- BOILER DRAFT DAMPERS
- REACTOR CONTROL RODS
- MACHINE TOOLS
- FEED ELEMENTS

PILOT
- BINARY/OR
- BIN.-DEC./
- CYCLIC/OR
- TERNARY

PILOT CONTROLLED DIGITAL VARIABLE SPEED DRIVES
- CONVEYOR DRIVES
- PUMP DRIVES
- FEEDER DRIVES
- ROLL DRIVES
- PRESS DRIVES
- MACHINE TOOLS

ADVANTAGES:
- OPERATES DIRECTLY FROM DIGITAL COMPUTERS, PROGRAMMERS, ETC.
- RESOLUTION (65,536 INC.) OR HIGHER.
- PERFECT REPEATABILITY AND STABILITY.
- PRECISION ACCURACY.

FERGUSON, HILLE & ASSOC. INC.
542 S. DEARBORN ST.
CHICAGO 5, ILLINOIS
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PATENT PENDING

CIRCLE 140 ON READER-SERVICE CARD

HIGH PRECISION TAPE DRIVE SPROCKETS by LaVezzi

Made to your specifications for
- ALL APPLICATIONS
- ALL SIZES AND FORMS
- IN ALL PRACTICAL MATERIALS
- IN SMALL OR LARGE QUANTITIES

Fine Finishes
Accurate Tooth Register
Perfect Tooth Size and Contour

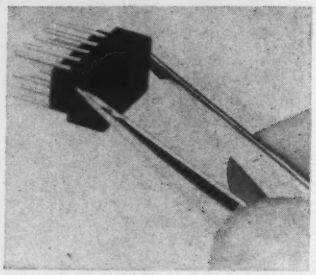
TEETH INTEGRAL WITH BODY

YOUR QUOTE REQUESTS AND INQUIRIES INVITED

LaVezzi MACHINE WORKS
4635 W. LAKE ST., CHICAGO 44, ILLINOIS
MACHINE PARTS OF EXTREME ACCURACY SINCE 1908

CIRCLE 141 ON READER-SERVICE CARD

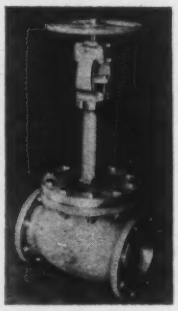
MAGNETIC LOGIC ELEMENT



New PICO-BIT subminiature logic element performs, under space-environment conditions, any of the nine basic logical functions: (1) AND, (2) OR, (3) INHIBIT (AND NOT), (4) BRANCH, (5) STORE, (6) TRANSFER, (7) DRIVE, (8) BINARY COUNT, (9) COMPLEMENT. Size ⅜" x ⅝" x ⅜".—*DI-AN Controls, Inc., 944 Dorchester Ave., Boston 25, Mass.*

CIRCLE 349 ON READER-SERVICE CARD

STAINLESS STEEL VALVES



New s.-s. stock Valve Line for liquid oxygen and other cryogenic applications includes gate and globe valves, in sizes from 1" to 8" with flanged or butt-weld end connections. Features extended bonnets, precision-lapped discs, extra heavy stems.—*Cooper Alloy Corp., Valve & Fitting Div., Hillside, N. J.*

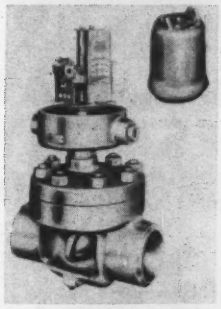
CIRCLE 350 ON READER-SERVICE CARD

INCREMENTAL ENCODER

New Incremental Encoder, Incrosyn Model IMI 15-210, produces 1024 pulses in a single turn with an accuracy of ±½ bit. Can be used as a bi-directional device by feeding into an up-down counter. Size: 1½" dia x 1¼" including electronics. Magnetic pickoff technique allows for slewing rates of up to 3000 rpm with a 100 kc carrier.—*Data Tech, 238 Main St., Cambridge 42, Mass.*

CIRCLE 351 ON READER-SERVICE CARD

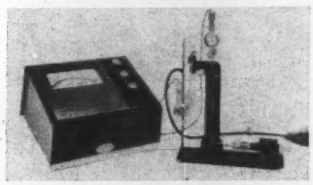
SWING-CHECK VALVE



New Model FCV Swing-Check Valve has valve disc magnetically coupled to the Magnetrol switch mechanism, which features mercury-to-mercury switch contacts. Remotely signals flow or no-flow through the valve; and/or provides an interlock safety control in start-up or shut-down, flow or no-flow. Also indicates position of valve disc.—*Magnetrol, Inc.*, 5300 *Belmont Rd., Downers Grove, Ill.*

CIRCLE 352 ON READER-SERVICE CARD

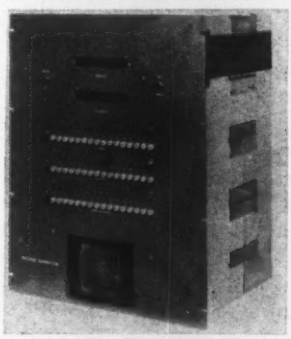
MICROTITRATOR



New Microtitrator detects end point electrometrically, even with less than a single drop. Capable of both oxidation-reduction titration as well as acidimetry-alkalimetry, with special electrodes for each process. Can be operated with the Coleman Companion pH meter or Metrion pH meter with adapter plug.—*Manostat Corp.*, 26 *N. Moore St., New York* 13, *N. Y.*

CIRCLE 353 ON READER-SERVICE CARD

SHAFT ENCODER TRANSLATOR



New shaft Encoder Translator, Type X116, is the final functional unit in a complex system containing four separate shaft position encoders. For each input angle (e.g., azimuth and elevation) there is a high-speed, high-resolution photo-electric encoder that converts the position of an inductosyn-driven secondary shaft into 13-bit binary gray code.—*Harvey-Wells Electronics, Inc.*, 14 *Huron Dr., Natick, Mass.*

CIRCLE 354 ON READER-SERVICE CARD

STORE...
CONVERT...
DELAY...
CONTROL...
TIME...
COUNT...

with this VERSATILE 10-STAGE MAGNETIC REGISTER

This **proven** plug-in can wear at least six different hats in your digital systems. Draws less than flea-power from a single ±15% voltage source. Maintains 40:1 ONE:ZERO ratio. Cascades without limit. We mass-produce eleven standard designs up to 750 KC, hence can sell them at prices that dishearten competition. So reliable we use them ourselves!

Let us show you how to play the hat game with the SRA-10. A bundle of informative, inspiring literature awaits you. Write **today.**

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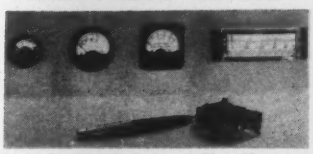
magnetic digital/analog systems and components

CIRCLE 142 ON READER-SERVICE CARD

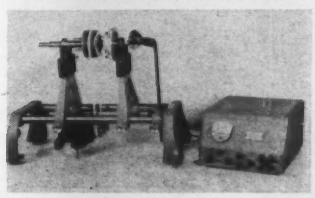
MINI PANEL METERS



New line of internally-illuminated miniature Panel Meters includes 1"-barrel-diameter Meters as well as 1½" meters. Two internally-illuminated side-indicator panel meters are also available. 28-volt illumination is standard, with 6- or 14-volt optional. Light source can be used as a built-in visual alarm or "off-on" indicator.—*International Instruments, Inc.*, 88 *Marsh Hill Rd., Orange, Conn.*

CIRCLE 355 ON READER-SERVICE CARD

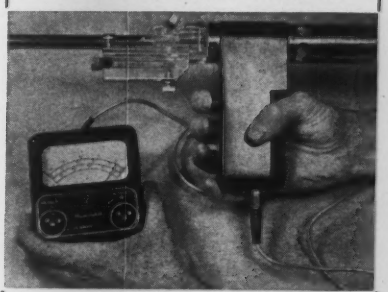
BALANCING MACHINE



New portable Balancing Machine, Type MU 6, is a sensitive system with measurable unbalance displacement of 10 μin (0.000,010"). Requires no hold-downs or foundations.—*Micro-Balancing, Inc., Herricks Rd., Garden City Park, L. I., N. Y.*

CIRCLE 356 ON READER-SERVICE CARD

Humidity measurements within ± 0.5% RH!



A+ HYGROPHIL
thermistor psychrometer

- Measures temperatures from 10°F to 176°F
- Response time: 10 to 20 seconds for final reading
- Reproducible readings every time. Readability ¼°
- Indicates wet and dry bulb thermistor (resistance temperature detector) readings of air temperatures.

$290 complete with case
Specify F° or C° scale

Write for Bulletin

A+® **Atkins Technical Inc.**
1276 W. Third Street
Cleveland 13, Ohio
Phone: SU 1-1332
temperature and humidity instrumentation

CIRCLE 143 ON READER-SERVICE CARD

HERE'S THE FIRST SMALL COMPLETE DATA-ACQUISITION SYSTEM

The new low-cost Genisco APD Data Acquisition system is a complete and compact solid-state packaged system designed to meet a wide range of instrumentation requirements. You can use it to read out thermocouples, resistance thermometers, strain-gage transducers or any other DC voltage low-impedance sensors. Modular plug-in board design allows great flexibility—one chassis can provide a complete 20-channel system.

Data is sampled at 20 samples per second; repeatability is 0.1% of full scale. Output can be shown or recorded directly in engineering units with sign indication and channel identification. Readout can be converted to punch tape, magnetic tape, typewriter or other storage medium.

The new Genisco APD requires low power and is ideal for portable, laboratory, or field use. Call or write today for prices and complete details.

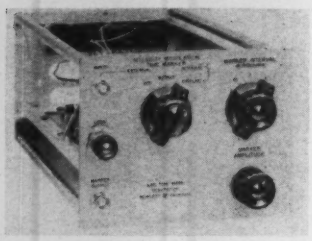
***Analog-to-Pulse Duration**
Patent Applied For

Genisco
INCORPORATED

2233 Federal Ave., Los Angeles 64, California

CIRCLE 144 ON READER-SERVICE CARD

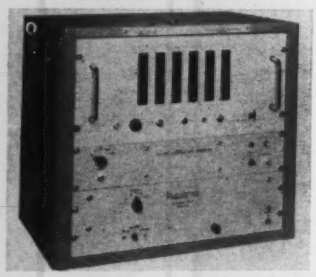
MARKER GENERATOR



New Model 166B Marker Generator provides marker intervals of 10 μsec, 1 μsec or 0.1 μsec with interval accuracy of ±0.5% for measurement of pulse rise time, duration and decay time; and time measurement on oscilloscope sweep rates.—*Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.*

CIRCLE 357 ON READER-SERVICE CARD

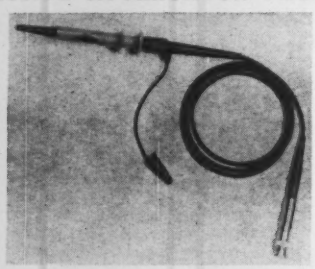
DIGITAL RECORDER



New digital Integrator-Recorder-Controller, the CRS-1 (Control Recording System), accepts output signals (100 mv full scale) from analytical instrumentation detectors and converts it to digital recordings on digital printer or typewriter, punched cards or paper tape, or digital magnetic recorder. Control unit has solid-state circuitry. Details in bulletin.—*Infotronics Corp., 1401 South Post Oak Rd., Houston 27, Tex.*

CIRCLE 358 ON READER-SERVICE CARD

PASSIVE ATTENUATOR PROBE



New Type 4290 is a 10:1 fixed-ratio Attenuator Probe for oscilloscopes with bandwidths from dc to more than 60 Mc. Equipped with adjustable capacitor. Handles input voltages of 1200 v (±600 v). Features a completely shielded retractile tip.—*Allen B. Du Mont Labs., Divs. Fairchild Camera and Instrument Corp., 750 Bloomfield Ave., Clifton, N. J.*

CIRCLE 359 ON READER-SERVICE CARD

TODAY'S BEST BUY IN AUTOMATIC TEST-DATA INTEGRATION

ELECTRONIC INTEGRATOR PX 592 **$795**

IDEAL FOR USE WITH GAS CHROMATOGRAPHS

In just a few short months RIG's new Electronic Integrator PX 592 has won wide acclaim as the ideal answer to a long-standing need among users of analytical instruments: An inexpensive accessory instrument for use with standard recorders to automatically integrate test data with the inherent precision and accuracy of the recording instrument itself.

Check *and compare* the PX 592's remarkably low price and outstanding operating features . . . and you'll see why so many companies hail it as today's best buy.

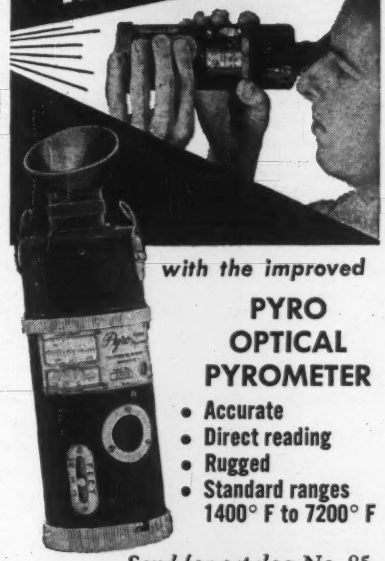
- **Can be used with any standard servo-drive recorder.**
- **Records both variable and integral with one pen (see chart above).**
- **Resets automatically at full-scale integral reading.**
- **Excellent long-term day after day repeatability.**
- **Built-in adjustable threshold minimizes noise and zero errors.**
- **Integral time constant is three days.**
- **Pipping pen may be used to display each reset.**
- **Continuous integral recording possible using 2nd pen.**
- **Special low-cost control unit available for automatic readout and reset.**

For complete details, write for Bulletin No. 041.

RIDGEFIELD INSTRUMENT GROUP
a Schlumberger division
Ridgefield, Conn., P.O. Box 337, IDlewood 8-6571

CIRCLE 145 ON READER-SERVICE CARD

READ TEMPERATURES INSTANTLY



with the improved

PYRO OPTICAL PYROMETER

- Accurate
- Direct reading
- Rugged
- Standard ranges 1400° F to 7200° F

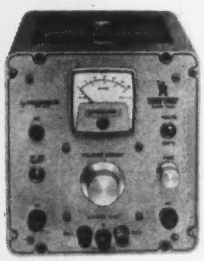
Send for catalog No. 85.

PYROMETER INSTRUMENT CO., INC.
BERGENFIELD 4, NEW JERSEY

CIRCLE 146 ON READER-SERVICE CARD

NEW LOW PRICE!

MODEL 1010T WITH ROBOTEC overload and short protection and HEATRAN electronic dissipation control



$339.50 FOB FACTORY

Other Models Available. Write for Catalog

SEMICONDUCTORIZED POWER SUPPLY 1-100 VDC 0-1.0 AMP

High efficiency, stabilized solid state DC power supply with .05% regulation, 1 millivolt ripple, .015 ohm source impedance, 50 microsecond response time, 55-440 cycle input.

IMMEDIATE DELIVERY

Power Designs inc.
1700 SHAMES DRIVE, WESTBURY, NEW YORK
EDgewood 3-6200 (LD Area Code 516)

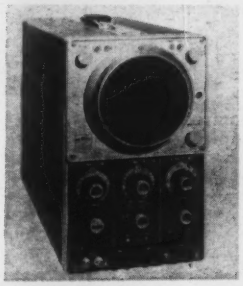
CIRCLE 147 ON READER-SERVICE CARD

DATA PROCESSING ACCESSORY

New Type 905 sigle-section Control Panel can be used to replace jack-type panels and wires, and new panel Conversion Kit allows a Type 901 jack-type panel to be changed into a 905 self-contacting panel at the customer's location.—*International Business Machines Corp., Data Processing Div., 112 East Post Rd., White Plains, N. Y.*

CIRCLE 360 ON READER-SERVICE CARD

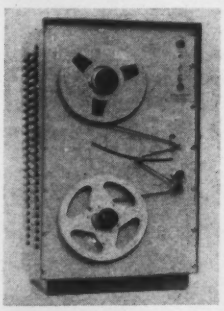
SENSITIVE SCOPE



New Type 403-B Oscilloscope has sensitivity of 50 μv/cm to permit resolution of signals as low as 10 μv. Pheonomena that are barely determinable within a dc-to-1-mc frequency range are easily detected. Scope is useful beyond 3 Mc and features high amplification with very low noise input. Displays non-amplified outputs from most strain gages, pressure pick-ups, accelerometers, and other transducers.—*Allen B. Du Mont Labs., Divs. Fairchild Camera and Instrument Corp., 750 Bloomfield Ave., Clifton, N. J.*

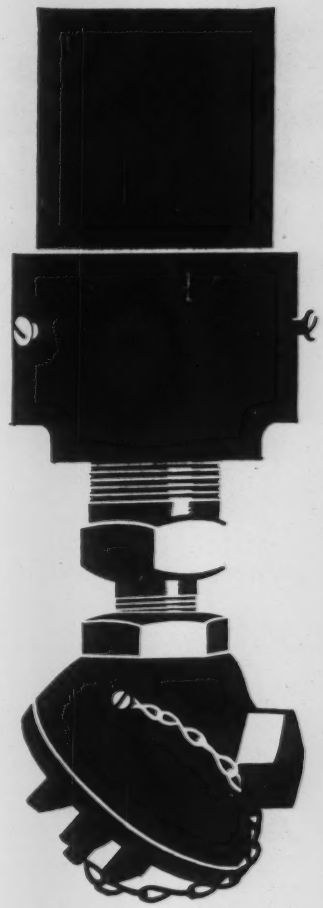
CIRCLE 361 ON READER-SERVICE CARD

MAGNETIC TAPE REWIND UNIT



New high-speed universal-hub Magnetic Tape Rewind Unit, Model TR-300, spools a 10½" reel in 90 sec. Accepts NAB or IBM tape reels without adapters, handles ½" or 1" width tapes. Average rewind speed is 500 ips.—*Electronic Engineering Co. of Calif., Automation Div., 1601 East Chestnut Ave., Santa Ana, Calif.*

CIRCLE 362 ON READER-SERVICE CARD



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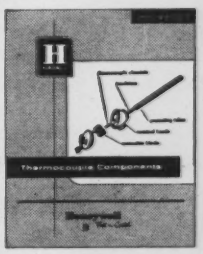
Wires, insulators, protecting tubes, heads, blocks, connectors and miscellaneous components—supplied in countless combinations, for highest possible accuracy in any given application. Thermocouple components are among many thousands of accessories—all available from a single dependable source—that can help your instruments perform at their very best.



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Clean Dry Oil-Free Compressed Air

An Adams aftercooler and cyclone separator installed in your instrument air supply cools the discharge air to within 2° of cooling water temperature. Over 90% of the moisture and virtually all of the oil are condensed. The exclusive Adams cyclone separator then removes the condensed liquid oil and water and other foreign material with uniform high efficiency — over the entire operating range. This air is entirely suitable for air motor and most control applications. When bone dry air is needed, the chemical drier load is then limited only to polishing action, since the bulk of the moisture will have been removed by lower cost condensation. Why not review the cost cutting advantages of an Adams aftercooler-separator combination? Ask today for your free copy of Bulletin 715. R. P. Adams Co., Inc., 265 East Park Drive, Buffalo 17, New York.

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CIRCLE 149 ON READER-SERVICE CARD

What dimension? Where? How fast? How many?

These quantities and many others may be accurately and instantaneously (20 μs) determined by use of the Bently distance detector.

The Bently distance detector is a precision electro-mechanical transducer. It generates a directly following (D.C.) voltage as a function of distance between its sensor head and any electrically conducting surface. Available sensitivities allow measurements from micro inches thru tenths of an inch.

D-152 precision distance detector (variable sensitivity) . . . $147.00

Sensor heads for detection . . . from $ 10.00

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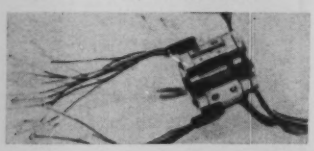
CIRCLE 150 ON READER-SERVICE CARD

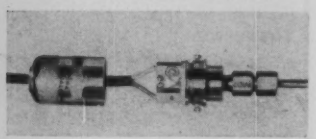
SLIP RING CAPSULE



New Slip Ring Capsule, made up of a complete brush block, bearing, and slip ring package, is manufactured from miniature to large units within overall specifications. Thus, manufacturer assumes full responsibility for quality control, design, adaptability and fully tested performance.—*Electro-Tec Corp.*, 10 *Romanelli Ave., South Hackensack, N. J.*

CIRCLE 363 ON READER-SERVICE CARD

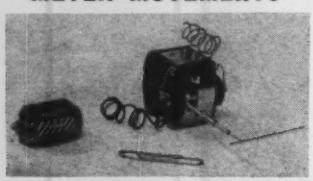
THERMOCOUPLE HEAD



New Thermocouple Head for temperatures to 1500°F has aluminum oxide terminal block in head which can accommodate 30- to 14-gage lead wire.—*Conax Corp.*, 2300 *Walden Ave., Buffalo* 25, *N. Y.*

CIRCLE 364 ON READER-SERVICE CARD

METER MOVEMENTS



New line of Miniature Mechanisms includes the high-torque Type AM-50 and flag Type AM-20 mechanism, both self-shielding, with a moving-coil type of movement and internal permanent magnet.—*International Instruments, Inc.*, 88 *Marsh Hill Rd., Orange, Conn.*

CIRCLE 365 ON READER-SERVICE CARD

RATIO COMPUTER

New Model 557-2B Ratio Computer accepts two independent d-c signals as low as 10 mv full scale per channel and computes their ratio to an accuracy of 1%. Employing chopper and a-c circuitry throughout, the unit has virtually no drift.—*Magnetic Instruments Co., Inc., Thornwood, N. Y.*

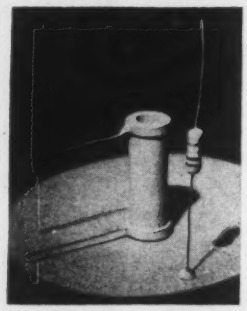
CIRCLE 366 ON READER-SERVICE CARD

RECORDER CHARTS

New Charts use "eye eaze" gray ink for longitudinal and cross lines and "maximum contrast" blue for range and time numbers. 6" wide, 103" long.—*Esterline Angus Instrument Co., Inc., Box* 596, *Indianapolis* 6, *Ind.*

CIRCLE 367 ON READER-SERVICE CARD

CARBON-DEPOSITED RESISTOR



New low-priced quality carbon-deposited Resistor Line includes five types (lead configuration) with power ratings ranging from ⅛ to 8, voltages to 1000 v and resistances from 5 ohms to 20 Mohms. Tolerances are held to standard commercial and military requirements (5 and 10%).—*Fi-Ohm Co. Suite* 1417*E*, 360 *N. Michigan Ave., Chicago* 1, *Ill.*

CIRCLE 368 ON READER-SERVICE CARD

NEW LITERATURE

PRESSURE, FORCE, WEIGHT

PRESSURE AND VACUUM GAGES. 32-page Catalog C70-1a describes instruments for measuring, indicating, recording, and controlling pressures and vacuums involved in industrial processes.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Phila. 44, Pa.

CIRCLE 369 ON READER-SERVICE CARD

PRESSURE REGULATORS. 12-page Bulletin 116 illustrates and describes American-line pressure regulators (direct acting, reverse acting, and control valves).—Manning, Maxwell & Moore, Inc., Stratford, Conn.

CIRCLE 370 ON READER-SERVICE CARD

PRESSURE TRANSDUCER. 2-page Bulletin 4350 describes Type 4-350 pressure transducer for extra-rugged service environments.—Consolidated Electrodynamics Corp., Subs. Bell & Howell, 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 371 ON READER-SERVICE CARD

STRAIN GAGE TERMINALS. 4-page Product Data 4340 illustrates and describes nine types of strain-gage wiring terminals.—Baldwin-Lima-Hamilton, Electronics & Instrumentation Div., Waltham 54, Mass.

CIRCLE 372 ON READER-SERVICE CARD

BULK WEIGHING SYSTEM. 4-page Form 2490a describes bulk weighing systems.—Toledo Scale Div., Toledo Scale Corp., Toledo 12, Ohio.

CIRCLE 373 ON READER-SERVICE CARD

LOAD CELL SYSTEMS. 12-page Bulletin R-2 illustrates uses of remote indicating load cell systems.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

CIRCLE 374 ON READER-SERVICE CARD

PRESSURE GAGES. 32-page Catalog DH-54 illustrates and describes pressure, vacuum and compound indicating gages.—Helicoid Gage Div., American Chain & Cable Company, Inc., Bridgeport 2, Conn.

CIRCLE 375 ON READER-SERVICE CARD

PRESSURE REGULATORS. 4-page Bulletin 123 describes Type HPC spring-loaded, pilot-loaded, and pilot-loaded with downstream bleed pressure regulators.—American Meter Co., 920 Payne Ave., Erie 6, Pa.

CIRCLE 376 ON READER-SERVICE CARD

PRESSURE REGULATOR. 2-page bulletin describes stainless-steel Regulator for compressed gases.—Thermco Instrument Corp., U. S. #20, La Porte, Ind.

CIRCLE 377 ON READER-SERVICE CARD

PNEUMATIC VALVE Position Transmitter for translating position into proportional output pressure is discussed in 2-page bulletin.—B-I-F Industries, Box 276, Providence 1, R. I.

CIRCLE 378 ON READER-SERVICE CARD

SPEED WEIGHING. 4-page brochure, Form 2112a, describes Model 3012 Speedweigh scale.—Toledo Scale Div., Toledo Scale Corp., Toledo 12, Ohio.

CIRCLE 379 ON READER-SERVICE CARD

WELDABLE STRAIN GAGES. 2-page Flyer SG-1A contains illustrations, specs, and graphs on weldable strain gages.—Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.

CIRCLE 380 ON READER-SERVICE CARD

TEMPERATURE

AIRBORNE TEMP INDICATOR. 6-page Spec Sheet DST-461 illustrates and describes Model DST-16 exhaust-gas and turbine inlet temperature indicator.—Conair (Consolidated Airborne Systems, Inc.), 900 Third Ave., New Hyde Park, L. I., N. Y.

CIRCLE 381 ON READER-SERVICE CARD

THERMOCOUPLE WIRE. 12-page Bulletin 1-500 describes Xactpac sheathed thermocouple wire and accessories.—Claud S. Gordon Co., 3000 S. Wallace St., Chicago 16, Ill.

CIRCLE 382 ON READER-SERVICE CARD

THERMOCOUPLES. 6-page Bulletin 4336 describes micro-miniature thermocouples.—Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.

CIRCLE 383 ON READER-SERVICE CARD

THERMOCOUPLES. 4-page Bulletin 161-A describes metal-sheathed thermocouples.—Harco Laboratories, Inc., 77 Olive St., New Haven, Conn.

CIRCLE 384 ON READER-SERVICE CARD

THERMOCOUPLES. Catalog 3.8A describes AerOpak thermocouples for use in nuclear, missiles, aircraft, industrial and process fields.—Aero Research Instrument Co., 315 N. Aberdeen St., Chicago 7, Ill.

CIRCLE 385 ON READER-SERVICE CARD

THERMAL CONDUCTIVITY. 2-page Bulletin MI-CE 461 describes Micro Cell Model JDC-133 thermal conductivity detector.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.

CIRCLE 386 ON READER-SERVICE CARD

TEMPERATURE TRANSDUCERS. 4-page Product Note 3010 describes platinum resistance Weld-On temperature transducers.—Trans-Sonics, Inc., Box 328, Lexington, Mass.

CIRCLE 387 ON READER-SERVICE CARD

SEA-WATER TEMP TRANSDUCER. 2-page bulletin describes Type T-4005 Sea Water Temperature Transducer.—Trans-Sonics, Inc., Box 328, Lexington, Mass.

CIRCLE 388 ON READER-SERVICE CARD

FLOW, PUMPS

FUEL INJECTION. 4-page Bulletin BTP15 describes injection of gaseous and liquid hydrocarbon fuels at blast furnace tuyeres.—Hagan Chemicals & Controls, Inc., Hagan Center, Pittsburgh 30, Pa.

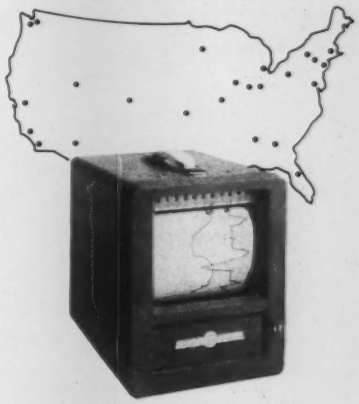
CIRCLE 389 ON READER-SERVICE CARD

VARIAN

Potentiometer

RECORDERS

Preferred nationwide because you get . . .



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For Use As Power Supply For Strain Gages, Resistance Bridges; as voltage standards, filament source, etc. Supplies isolated, regulated, stable DC voltage 0-10 at currents up to 50 Ma.

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For Use As Bucking Potential, Reference Voltage, etc. Supplies an isolated, accurate, stable voltage of 1.000, 1.019, 6.2, 8.4, 9.0, 9.3, 11.7 at currents of 0.5, 1.0, 10.0 Ma.

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CIRCLE 152 ON READER-SERVICE CARD

LIQUID BLENDING. 8-page Bulletin 650 discusses advantages of line blending.—Blackmer Pump Co., Grand Rapids, Mich.
CIRCLE 390 ON READER-SERVICE CARD

FLOW SLIDE RULE contains scales for liquid, and steam-and-gas-flow determinations.—Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Box 400, Knoxville 1, Tenn.
CIRCLE 391 ON READER-SERVICE CARD

FUEL OIL BLENDING. 4-page Bulletin 90-29-03 discusses continuous blending of various grades of fuel oil to attain desired blend viscosity.—Fischer & Porter Co., 908 Jacksonville Rd., Warminster, Pa.
CIRCLE 392 ON READER-SERVICE CARD

ROTARY GAS METERS. 2-page Specification S-RMI-125LM describes construction, installation, features of line-mounted gas meters.—Roots-Connersville Blower Div., Dresser Industries, Inc., Connersville, Ind.
CIRCLE 393 ON READER-SERVICE CARD

COUNT, TIME

BI-DIRECTIONAL COUNTERS. 2-page bulletin describes high-speed, bi-directional Series A-1805 Electronic Counters.—Veeder-Root Inc., Electronic Controls Div., 70 Sargeant St., Hartford 2, Conn.
CIRCLE 394 ON READER-SERVICE CARD

PREDETERMINING COUNTERS. 2-page bulletin, Form 227845, describes and specifies Series 1801 of electric predetermining counting devices.—Veeder-Root Inc., Electronic Controls Div., Danvers, Mass.
CIRCLE 395 ON READER-SERVICE CARD

DIAL TIMER. 8-page Bulletin N-305B describes new Series 305B Automatic Reset Dial Timer for time control of industrial processes, laboratory and machine automation.—Automatic Timing & Controls, Inc., King of Prussia, Pa.
CIRCLE 396 ON READER-SERVICE CARD

TACHOMETERS. 2-page Bulletin TAC-1 describes electrical tachometers for control of telemetering applications.—Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.
CIRCLE 397 ON READER-SERVICE CARD

MATERIALS HANDLING

CONTINUOUS BLENDING. 2-page data sheet and collection of bulletins describe problem of blending high and low volatile coals to prevent excessive expansion in coke ovens, suggests solution of blending by weight with Conveyoflo Meter Model Series 550.—B-I-F Industries, Box 276, Providence 1, R. I.
CIRCLE 398 ON READER-SERVICE CARD

TABLE FEEDER. 4-page Bulletin, Ref. No. 23-02.20-1, describes self-contained, portable table feeder for dry materials, Model 23-02.—B-I-F Industries, Box 276, Providence 1, R. I.
CIRCLE 399 ON READER-SERVICE CARD

RECORDERS

PNEUMATIC RECEIVER. 4-page Bulletin A134 contains information on Series 670 Metagraphic pneumatic receiver.—Bristol Co., Waterbury 20, Conn.
CIRCLE 400 ON READER-SERVICE CARD

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T. H. GARNER COMPANY

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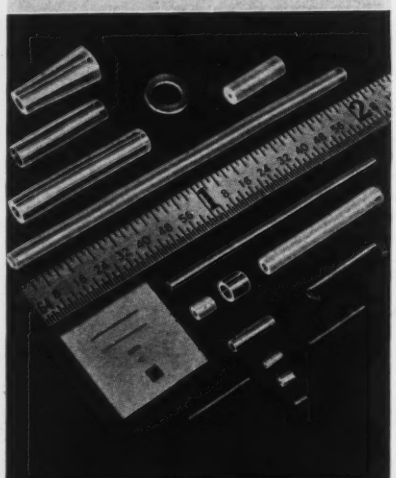

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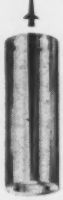

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CIRCLE 153 ON READER-SERVICE CARD

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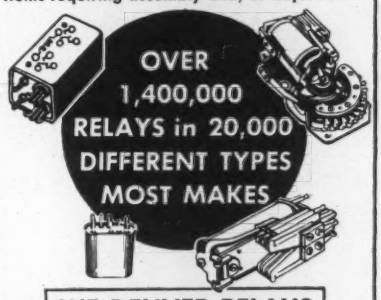

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CIRCLE 154 ON READER-SERVICE CARD

SILICON DIODES. 4-page Catalog D-100 lists characteristics of 86 conventional glass silicon diodes.—Computer Diode Corp., 250 Garibaldi Ave., Lodi, N. J.

CIRCLE 449 ON READER-SERVICE CARD

FLAME IONIZATION DETECTOR. 8-page bulletin (Aerograph Research Notes) describes Hy-FI gas chromatograph with hydrogen flame ionization detector.—Wilkens Instrument and Research, Box 313, Walnut Creek, Calif.

CIRCLE 450 ON READER-SERVICE CARD

PROCESS REFRACTOMETER. 4-page Bulletin 4-1061 describes with schematics line of refractometers including digital indicating, in-line, lab recording, and process differential types.—Waters Associates, 45 Franklin St., Framingham, Mass.

CIRCLE 451 ON READER-SERVICE CARD

MEDICAL APPARATUS. 4-page brochure illustrates and describes several types of lung-function apparatus made by Godart-Mijnhardt NV, Holland.—Instrumentation Associates Inc., 17 West 60th St., New York 23, N. Y.

CIRCLE 452 ON READER-SERVICE CARD

FLAME DETECTOR. 2-page Bulletin E66-2 describes Flamon Detector which senses presence of flame and operates internal relay or transmits signal to static switch.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

CIRCLE 453 ON READER-SERVICE CARD

DIGITAL RECORDER. 6-page flyer describes portable IDR 6150 incremental digital recorder.—Minneapolis-Honeywell, Industrial Systems Div., Beltsville, Md.

CIRCLE 401 ON READER-SERVICE CARD

RECTILINEAR RECORDER. 16-page Bulletin C200-002 contains description and specs of miniature, standard, and double-size rectilinear recorders.—Curtiss-Wright, Princeton Div., Box 110, Princeton, N. J.

CIRCLE 402 ON READER-SERVICE CARD

OSCILLOSCOPE CAMERA. 4-page pamphlet details C-12 Camera.—Tektronix, Inc., Box 500, Beaverton, Ore.

CIRCLE 403 ON READER-SERVICE CARD

INCREMENTAL ANALYZER. 2-page bulletin illustrates and describes Model 5880 general-purpose input adapter for servo recorders.—Tensor Electric Development Co., Inc., 1873 Eastern Parkway, Brooklyn 33, N. Y.

CIRCLE 404 ON READER-SERVICE CARD

STRIP CHART RECORDERS. Binder of ten 2-page bulletins contains descriptions and specs of strip chart recorders and accessories.—Westronics, Inc., 3605 McCart, Fort Worth, Texas.

CIRCLE 405 ON READER-SERVICE CARD

TESTING

TEST GAGES. 8-page Bulletin 363 describes Ashcroft test gages and gage testing equipment.—Manning, Maxwell & Moore, Inc., Stratford, Conn.

CIRCLE 406 ON READER-SERVICE CARD

TEST INSTRUMENTS. 12-page booklet details special-purpose test instruments, including direct-reading L-C Meter, Indicator Unit, Waveform Generator, 2 Pulse Generators, and 2 Power Supplies.—Tektronix, Inc., Box 500, Beaverton, Ore.

CIRCLE 407 ON READER-SERVICE CARD

TV TEST EQUIPMENT. 16-page booklet describes oscilloscope, waveform monitor, and color-TV vectorscope.—Tektronix, Inc., Box 500, Beaverton, Ore.

CIRCLE 408 ON READER-SERVICE CARD

POWER SUPPLIES

POWER SUPPLIES. 2-page flyer describes new Series 170 modular, regulated power supplies.—Quan-Tech Laboratories, Inc., Boonton, N. J.

CIRCLE 409 ON READER-SERVICE CARD

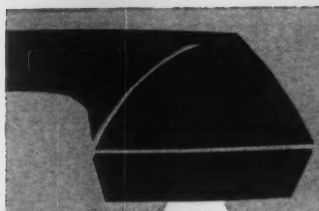
ELECTRICAL, ELECTRONIC INSTRUMENTS

MICROAMMETER. 6-page Bulletin 59 illustrates, describes, and prices "Microva" 20-range current and voltage meter, combining advantages of galvanometer and sensitive VTVM.—James G. Biddle Co., 1316 Arch St., Phila. 7, Pa.

CIRCLE 410 ON READER-SERVICE CARD

TIME CODE GENERATOR. 4-page Bulletin 6190-A describes and block diagrams Time Code Generator, Model 6190.—Epsco-West, 240 E. Palais Rd., Anaheim, Calif.

CIRCLE 411 ON READER-SERVICE CARD



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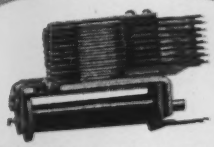
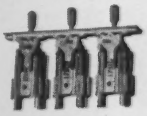
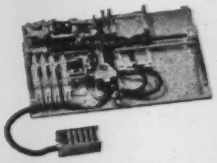


RELAYS: Wide range, for electromechanical switching. Send for Bulletin T-5000R2.



KEYS: Cam-type and push-button. Send for Bulletin T-5002R.



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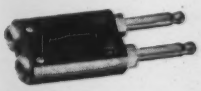

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SWEEP DELAY GENERATOR. 2-page Data Sheet 116D EEM 2900 describes Model 166D Sweep Delay Generator. —Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

CIRCLE 412 ON READER-SERVICE CARD

RECORDING D-C MICROAMMETER. 4-page Catalog Section 41 describes versatility of 50-microamp Direct Current Microammeter.—Esterline Angus Instrument Co., Inc., Box 596, Indianapolis 6, Ind.

CIRCLE 413 ON READER-SERVICE CARD

ELECTRICAL MEASUREMENTS. 8-page Condensed Catalog A-26 describes systems for precision measurements of resistance, impedance, capacitance, etc.—Electro Scientific Industries, (formerly Electro-Measurements, Inc.), 7524 S. W. Macadam Ave., Portland 19, Ore.

CIRCLE 414 ON READER-SERVICE CARD

DATA HANDLING

TAPE RECORDER/REPRODUCER. 4-page bulletin describes VR-2600 Wide-Band Magnetic Tape Recorder/Reproducer.—Consolidated Electrodynamics Corp., Subs. of Bell & Howell Co., 360 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 415 ON READER-SERVICE CARD

TAPE RECORDER/REPRODUCER. 4-page bulletin describes GL-2510 Continuous-Loop Recorder/Reproducer.—Data Recorders Div., Consolidated Electrodynamics Corp., Subs. of Bell & Howell Co., 360 Sierra Madre Villa, Pasadena, Calif.

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TAPE RECORD/REPRODUCER SYSTEM. 4-page folder describes Model 102A two-channel analog data tape recorder/reproducer system with linearity of ±0.2%.—Mnemotron Corp., 45 S. Main St., Pearl River, N. Y.

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DIGITAL MODULES. 12-page Catalog H is reprint of "A Synchronous Logic Technique for Sixteen Megacycle Clock Rates" presented at 1960 Wescon Conference.—Computer Control Co., Inc., 983 Concord St., Framingham, Mass.

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LOGIC CIRCUIT PLUG-IN MODULES. 4-page Bulletin 60-D describes Series 2011 Logix Blocks, a complete set of very-high-speed digital logic circuit plug-ins.—Rese Engineering, Inc., A and Courtland Sts., Phila. 20, Pa.

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DIGITAL MEASURING SYSTEM. 12-page data file describes DME all-purpose digital measuring system built around a universal counter-timer. —Computer Measurements Co., 12970 Bradley Ave., Sylmar, Calif.

CIRCLE 420 ON READER-SERVICE CARD

TAPE READER. 2-page Bulletin 361 describes 80-bit bi-directional punched-tape readers TP-480 and TP-482.—Electronic Engineering Co. of Calif., Automation Div., 1601 E. Chestnut Ave., Santa Ana, Calif.

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X-Y PLOTTER. 2-page technical bulletin describes X-Y Plotter using digital logic.—Gerber Scientific Instrument Co., 89 Spruce St., Hartford, Conn.

CIRCLE 422 ON READER-SERVICE CARD

DATA HANDLING SYSTEMS. 16-page catalog describes digital and r-f systems and instruments.—Dymec Div. of Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

CIRCLE 423 ON READER-SERVICE CARD

PULSE-TO-STEP CONVERTER. 4-page Bulletin SS361 describes Slo-Syn® Translator which converts low-level signal pulses or square waves into correct switching sequence for Slo-Syn motors.—Superior Electric Co., Bristol, Conn.

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SOLID STATE MODULES. 4-page Bulletin 1008 describes multi-element components with simple inputs and outputs performing varied logic functions.—Burroughs Corp., Electronic Components Div., Plainfield, N. J.

CIRCLE 425 ON READER-SERVICE CARD

DATA ACQUISITION. 6-page folder describes DL-210 Data Acquisition System.—Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 426 ON READER-SERVICE CARD

FACSIMILE TRANSMITTER. 12-page booklet describes Pressfax Transmitter and Recorder for transmitting full size newspaper page proofs at high speed over video circuits.—Westrex Corp., Div. Litton Industries, 540 W. 58 St., New York 19, N. Y.

CIRCLE 427 ON READER-SERVICE CARD

AN/DIG CONVERTER. 2-page bulletin describes Capcoder analog-to-digital converter utilizing technique of capacitive charge transfer.—Towson Laboratories, Inc., 200 E. Joppa Rd., Baltimore 4, Md.

CIRCLE 428 ON READER-SERVICE CARD

ASYNCHRONOUS COMPUTER. 4-page report analyzes operation and advantages of Philco 2000 computers.—Philco Computer Div., Dept. NP, 4600 Welsh Rd., Willow Grove, Pa.

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ANALYTICAL

pH SYSTEM. 2-page Spec S914-1 describes integral Honeywell-Beckman system for pH measurement which consists of Model 75 Beckman pH Amplifier mounted in Honeywell ElectroniK 15 Potentiometric Recorder.—Minneapolis-Honeywell Regulator Co., Industrial Div., Wayne and Windrim Aves., Phila 44, Pa.

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INFRARED SPECTROPHOTOMETER. 8-page brochure describes new lightweight infrared spectrophotometer developed for airborne or satellite-borne spectral measurement applications.—Perkin-Elmer Corp., Norwalk, Conn.

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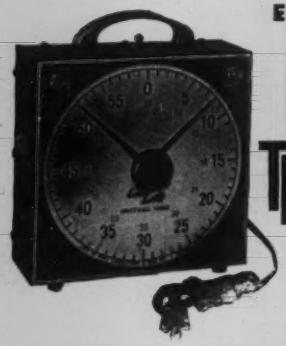

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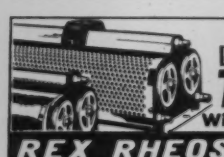

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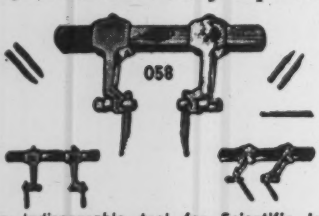

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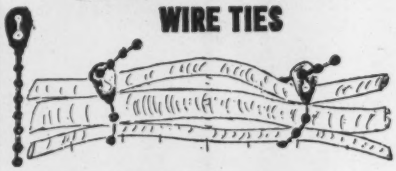

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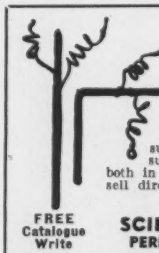

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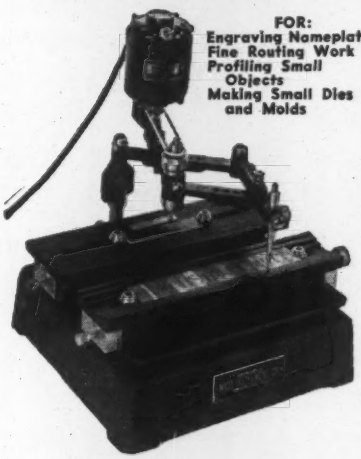

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MAGAMP. 2-page Brochure BMA-1 describes with specs and sketches bistable magnetic amplifier.—Microdot Inc., 220 Pasadena Ave., South Pasadena, Calif.

CIRCLE 433 ON READER-SERVICE CARD

MISCELLANEOUS

REFRIGERATED AIR DRYERS. 2-page Bulletin 610 describes three self-contained compressed-air dryers.—Zeks Industries, Inc., Edgemont, Pa.

CIRCLE 434 ON READER-SERVICE CARD

MALFUNCTIONS DETECTION. 4-page Application Report V-101 outlines how Vibraswitch malfunction detectors, mounted on turbines, fans, pumps, blowers and motors, provide automatic alarm or shutdown whenever they sense impending mechanical failure.—Aeronautical and Instrument Div., Robertshaw-Fulton Controls Co., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.

CIRCLE 435 ON READER-SERVICE CARD

RANGE DRIVES. 4-page brochure, Form 2028, explains application of U. S. Varidyne a-c controlled speeds systems to range drives (for paper, fabric, plastic, and metal strip).—U. S. Electrical Motors Inc., Box 2058 Terminal Annex, Los Angeles 54, Calif.

CIRCLE 436 ON READER-SERVICE CARD

VIBRATION TRANSDUCER. 24-page booklet discusses 2200 Series accelerometers with data on applications, piezoelectric materials, calibration techniques, etc.—Endevco Corp., 161 E. California Blvd., Pasadena, Calif.

CIRCLE 437 ON READER-SERVICE CARD

COMBUSTION CONTROL. 20-page Bulletin 1002 describes system engineering and line of control elements for combustion control.—Reliance Instrument Div., Electro-Mech Corp., 500 Livingston St., Norwood, N. J.

CIRCLE 438 ON READER-SERVICE CARD

GAS DENSITY DETECTOR. 4-page Bulletin GADE461 describes principle of operation and features of Model 091 Gas Density Detector.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.

CIRCLE 439 ON READER-SERVICE CARD

TRANSDUCER SWITCHING. 2-page Data Sheet 4406 describes transducer switching unit and Type 12 disc indicator.—Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp., 42 Fourth Ave., Waltham 54, Mass.

CIRCLE 440 ON READER-SERVICE CARD

DISPLAY SCANNER. 2-page Data Sheet 166C EEM 2900 describes and specifies Model 166C Display Scanner for oscilloscopes.—Hewlett-Packard Co., 1501 Page Mill Rd., Palo Alto, Calif.

CIRCLE 441 ON READER-SERVICE CARD

HUMIDITY IN ATMOSPHERE. 2-page Bulletin T-100 and spec sheet describe Model H-160-3 Humistor.—Conrad-Carson Electronics, Inc., Box 2396, Bostonia Station, El Cajon, Calif.

CIRCLE 442 ON READER-SERVICE CARD

FLEXIBLE COUPLINGS. 4-page Catalog 40 describes ½" to 1½" OD Flexible Couplings with set-screw and clamp-type hubs.—Naugler Engineering, Inc., 19 Madison Ave., Beverly, Mass.

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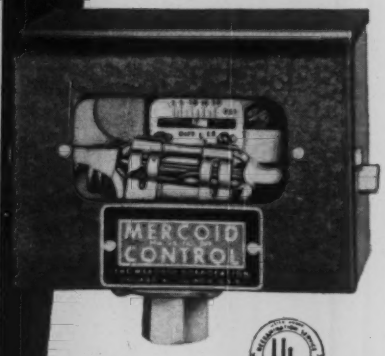

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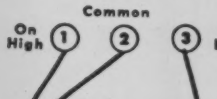

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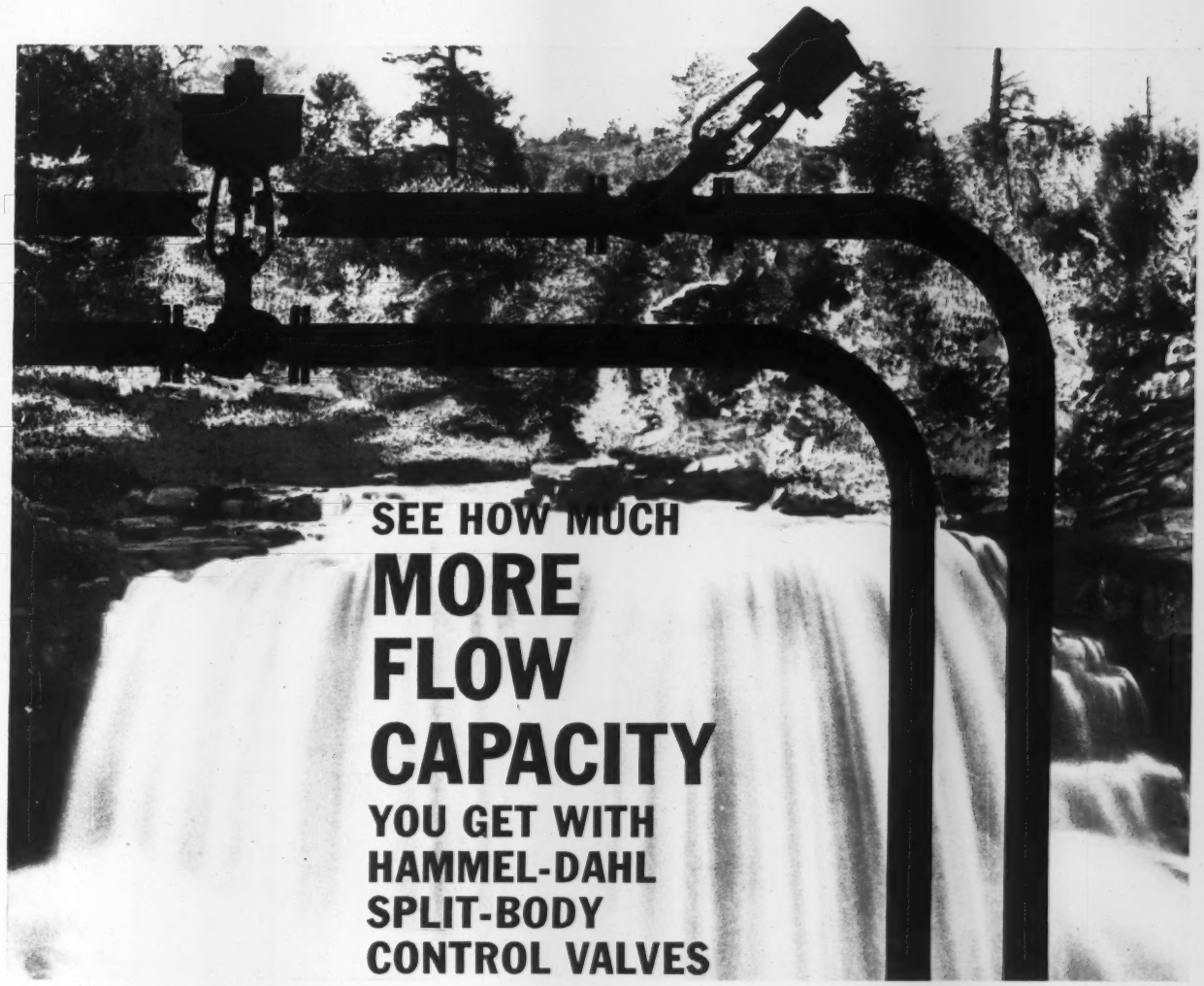

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1"	12	13	18	20	1"
1½"	26	33	50	60	1½"
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3"	107	135	225	244	3"
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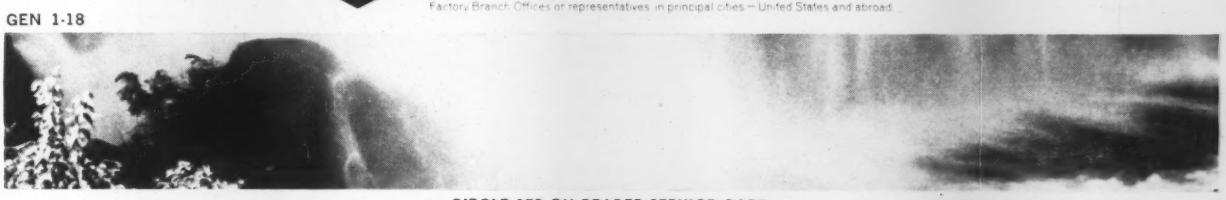

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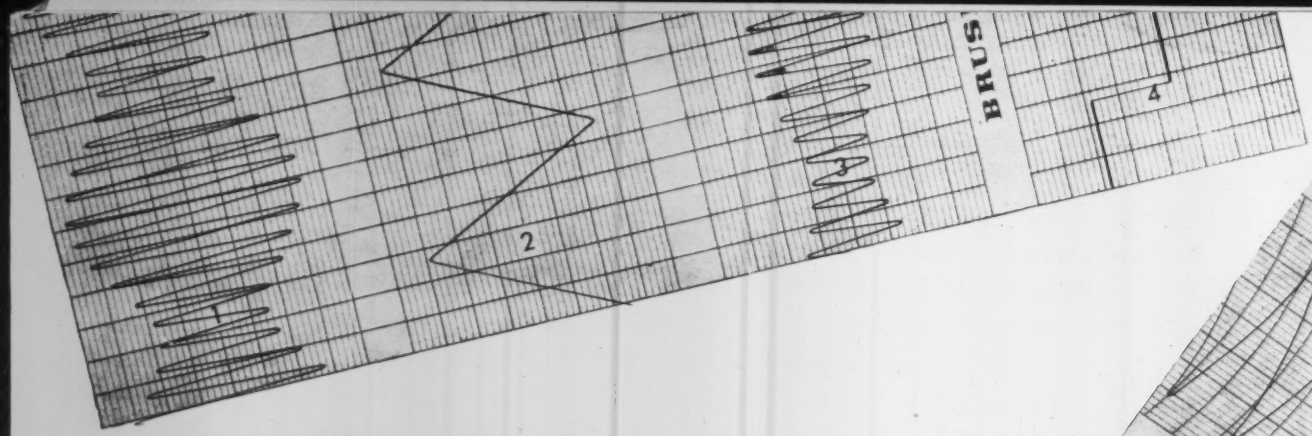

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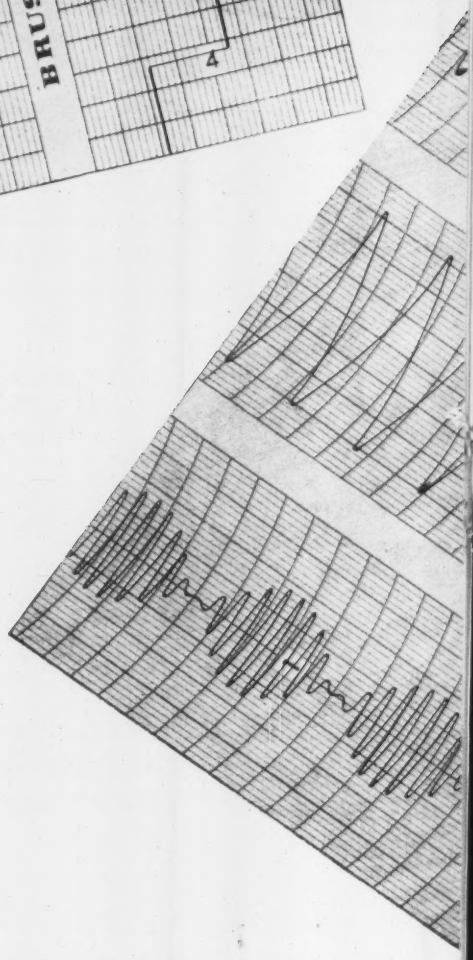

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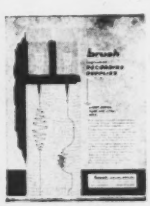

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